DIVISION 1
GENERAL REQUIREMENTS

SECTION 101
DEFINITIONS OF TERMS

101-1 GENERAL

Whenever the terms defined in this section are used in the contract, in any of the contract documents, or on the plans, the intended meaning of such terms shall be as defined in this section.

101-2 ABBREVIATIONS

AAN _____ American Association of Nurserymen
AAR _____ Association of American Railroads
AASHTO__ American Association of State Highway and Transportation Officials
ACI _____ American Concrete Institute
ADT_____ Annual Average Daily Traffic
AED_____ Associated Equipment Distributors
AGC _____ Associated General Contractors of America
AIA _____ American Institute of Architects
AISC _____ American Institute of Steel Construction
AISI_____ American Iron and Steel Institute
ANSI _____ American National Standards Institute, Inc.
ARA _____ American Railway Association
AREA ____ American Railway Engineering Association
ASLA ____ American Society of Landscape Architects
ASTM ____ American Society for Testing and Materials
ATIS _____ Alliance for Telecommunications Industry Solutions
AWG_____ American Wire Gauge
AWWA ___ American Water Works Association
AWS _____ American Welding Society
AWPA____ American Wood Preserver's Association
CALTRANS TEES____California DOT Transportation Electrical Equipment Specifications
CRSI _____ Concrete Reinforcing Steel Institute
DHV _____ Design Hourly Volume
EEI _____ Edison Electric Institute
EIA/TIA __ Electronics Industries Alliance/Telecommunications Industry Association
FHWA____ Federal Highway Administration, U.S. Department of Transportation
FSS _____ Federal Specifications and Standards, General Services Administration
FTMS ____ Federal Test Method Standard
GS _____ General Statutes of North Carolina
IES_____ Illuminating Engineering Society
IMSA_____ International Municipal Signal Association
ITS_____ Intelligent Transportation Systems
LED_____ Light Emitting Diode
MIL _____ Military Standard

MUTCD __ Manual of Uniform Traffic Control and the North Carolina Supplement thereto
NEC_____ National Electrical Code
NEMA____ National Electrical Manufacturers Association
NESC_____ National Electrical Safety Code
NTPEP____ National Transportation Product Evaluation Program
RMS _____ Root Mean Square
RUS CFR _ Rural Utilities Service & Code of Federal Regulations
SCTE_____ Society of Cable Telecommunications Engineers
SPIB _____ Southern Pine Inspection Bureau
SSPC _____ Society of Protective Coatings
UL _____ Underwriters' Laboratories, Inc.
UV_____ Ultraviolet

101-3 DEFINITIONS

ACT OF GOD

Events in nature so extraordinary that the history of climate variations and other conditions in the particular locality affords no reasonable warning of them.

ADDITIONAL WORK

Additional work is that which results from a change or alteration in the contract and for which there are existing contract unit prices.

ADMINISTRATOR

The State Highway Administrator.

ADVERTISEMENT

The public advertisement inviting bids for the construction of specific projects.

AMOUNT BID

The amount bid for a particular item of work in a proposal.

ARTICLE

A primary numbered subdivision of a section of the standard specifications.

AWARD

The decision of the Board of Transportation to accept the bid of the lowest responsible bidder for work that is subject to the furnishing of payment and performance bonds, and such other conditions as may be otherwise provided by law, the proposal, and these specifications.

BASE COURSE

That portion of the pavement structure of planned thickness placed immediately below the pavement or surface course.

BID (OR PROPOSAL)

Paper Bid: The offer of a bidder on the proposal furnished by the Department to perform the work and to furnish the labor and materials at the prices quoted.

Electronic Bid: The electronic offer of a bidder via Bid Express® to the Department to perform the work and to furnish the labor and materials at the prices quoted.

BID BOND OR BID DEPOSIT

The security furnished by the bidder with his bid as guaranty that he will furnish the required bonds and execute such documents as may be required if his bid is accepted.

BIDDER

An individual, partnership, firm, corporation, LLC or joint venture formally submitting a bid for the work contemplated.

BOARD OR BOARD OF TRANSPORTATION

The Board created by the provisions of G.S. 143B-350 for the purpose of formulating policies and priorities for the Department of Transportation, and awarding all highway construction contracts.

BRIDGE

A structure including supports, erected over a depression or an obstruction such as water, highway, or railway, and having a track or passage way for carrying traffic or other moving loads and having a length measured along the center of the roadway of more than 20 feet between undercopings of end supports, spring lines of arches, or between extreme ends of openings for multiple reinforced concrete box structures.

Bridge Length: The length of a bridge structure is the overall length measured along the line of survey stationing back to back of backwalls of abutments, if present, otherwise end to end of the bridge floor.

Bridge Width: The clear width measured at right angles to the longitudinal centerline of the bridge between the bottom of curbs, guard timbers or face of parapets, or in the case of multiple height of curbs, between the bottoms of the lower risers.

CALENDAR DAY

A day shown on the calendar beginning and ending at midnight.

CHIEF ENGINEER

The Chief Engineer, Operations, Division of Highways, North Carolina Department of Transportation acting directly or through his duly authorized representatives.

COMPLETION DATE

That date established as set forth in the contract or as revised by authorized extensions, by which it is required, established as that the work set forth in the contract be satisfactorily completed. When observation periods are required by the Specifications, they are not a part of the work to be completed by the completion date or intermediate contract times stated in the contract.

CONSTRUCTION EASEMENT

A right owned by the Department of Transportation in a parcel of land owned by a third party outside the highway right of way for the purpose of containing construction that exceeds the right of way.

CONTRACT

The executed agreement between the Department of Transportation and the successful bidder, covering the performance of the work and the compensation therefor.

The term contract is all inclusive with reference to all written agreements affecting a contractual relationship and all documents referred to therein, and shall specifically include, but not be limited to, the proposal, the printed contract form and all attachments thereto, the contract bonds, the plans, the standard specifications and all supplemental specifications thereto, the standard special provisions and the project special provisions contained in the proposal, and all executed supplemental agreements, all of which shall constitute one instrument.

All references to contracts shall include electronic agreements and printed paper agreements. These may include but not be limited to the electronic bid bond, non-collusion statement, debarment certifications, and award limits.

CONTRACT ITEM

A specifically described unit of work for which a unit or lump sum price is provided in the contract. Synonymous with *Pay Item*.

CONTRACT LUMP SUM PRICE

The amount bid for a lump sum item that has been submitted by the Contractor in his proposal.

CONTRACT PAYMENT BOND

A bond furnished by the Contractor and his corporate surety securing the payment of those furnishing labor, materials, and supplies for the construction of the project.

CONTRACT PERFORMANCE BOND

A bond furnished by the Contractor and his corporate surety guaranteeing the performance of the contract.

CONTRACT TIME

The number of calendar days inclusive between the date of availability and the completion date, said dates being established as set forth in the special provisions, including authorized extensions to the completion date.

CONTRACT UNIT PRICE

The unit bid price for a unit item that has been submitted by the Contractor in his proposal.

CONTRACTOR

The successful bidder to whom the contract has been awarded, and who has executed the contract and furnished acceptable contract bonds.

CULVERT

Any structure not classified as a bridge that provides an opening under the roadway.

CURRENT CONTROLLING OPERATION OR OPERATIONS

Any operation or operations, as determined by the Engineer, that if delayed would delay the completion of the project.

DATE OF AVAILABILITY

That date, established as set forth in the special provisions, by which it is anticipated that sufficient work sites within the project limits will be available for the Contractor to begin his controlling operations that are not otherwise limited by moratoriums, listed third party conflicts, or by weather conditions.

DEPARTMENT OR DEPARTMENT OF TRANSPORTATION

A principal department of the Executive Branch that performs the functions of planning, design, construction, and maintenance of an integrated statewide transportation system.

DIRECTOR OF CONSTRUCTION

The Director of Construction, Division of Highways, North Carolina Department of Transportation, acting directly or through his duly authorized representatives.

DIVISION OF HIGHWAYS

The division of the Department of Transportation that, under the direction of the Secretary of Transportation, carries out state highway planning, design, construction, and maintenance functions assigned to the Department of Transportation.

DRAINAGE EASEMENT

A right, owned by the Department of Transportation, in a parcel of land owned by a third party outside the highway right of way, to construct and maintain ditches, channels, or structures for directing the course and flow of water outside the highway right of way.

EASEMENT

A property right to use or control real property of another.

ENGINEER

The State Highway Administrator of the North Carolina Department of Transportation, acting directly or through a duly authorized representative, such representative acting within the scope of particular assigned duties or authority.

EQUIPMENT

All machinery and equipment, together with the necessary supplies, tools, and apparatus for upkeep and maintenance, all of which are necessary for the proper construction and acceptable completion of the work.

EXTRA WORK

Work found necessary or desirable to complete fully the work as contemplated in the contract for which payment is not provided for by the contract unit or lump sum prices in the original contract. Extra work shall not be work that in the terms of the contract is incidental to work for which there is a contract price or work that payment is included in some other contract unit or lump sum price.

FINAL ACCEPTANCE DATE

That date on which all work set forth in the contract and work modified by the Engineer is satisfactorily completed excluding any observation periods not specifically made a part of the work by the specifications or special provisions.

FINAL ESTIMATE

The document that contains a final statement of all quantities and total dollar amount for each item of work performed during the life of the contract including any adjustments to those amounts made under the terms of the contract. The final statement will be titled The Final Estimate and will be the document utilized to document final payment to the Contractor. Receipt of this document by the Contractor will begin the time frame for filing of a verified claim with the Department as provided for in G.S. 136-29 of the General Statutes of North Carolina.

FINAL ESTIMATE ASSEMBLY

As constructed plans and other project records that establish the final statement of quantities to be paid and document work performed on the project.

FORCE ACCOUNT NOTICE

A written notice to the Contractor that extra work ordered by the Engineer will be paid for as force account work.

FORCE ACCOUNT WORK

Work that is paid for in accordance with Article 109-3 or on the basis of the force account formula provided in the contract.

HIGHWAY

A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way. Synonymous with *Road* and *Street*.

HOUR

One of the 24 equal parts of a day.

INSPECTOR

The authorized representative of the Engineer assigned to make a detailed inspection of any or all portions of the work and materials.

INTERMEDIATE COMPLETION DATE

That date established as set forth in the special provisions or as revised by authorized extensions, by which date it is required that the portion of work set forth in the contract be satisfactorily completed.

INTERMEDIATE COMPLETION TIME

The time established as set forth in the special provisions or as revised by authorized extensions, by which it is required that the portion of work set forth in the contract be satisfactorily completed.

INTERMEDIATE CONTRACT TIME (DAYS)

The number of calendar days inclusive between the date of availability and the completion date, said days being established as set forth in the special provisions, or as revised by authorized extensions, by which it is required that a portion of that work set forth in the contract be satisfactorily completed.

INTERMEDIATE CONTRACT TIME (HOURS)

The number of hours inclusive between the time of availability and the intermediate completion time, said times being established as set forth in the special provisions, including authorized extensions to the intermediate completion time.

INVERT

The lowest point in the internal cross section of a pipe or other culvert.

INVITATION TO BID

The notification that bids will be received for the construction of specific projects.

- L -

LABORATORY

The testing laboratory of the Department of Transportation or any other testing laboratory that may be designated or approved by the Engineer.

LOCAL TRAFFIC

Traffic that must use the facility under construction in order to reach its destination.

MAJOR AND MINOR CONTRACT ITEMS

Major contract items are listed as such in the project special provisions. All other original contract items and extra work shall be considered as minor items.

MATERIALS

Any substances that may be incorporated into the construction of the project.

MEDIAN

The center section of a divided highway that separates the traffic lanes in one direction from the traffic lanes in the opposite direction.

MOBILIZATION

The work described in Article 800-1.

PAVEMENT STRUCTURE

The combination of base and surface courses placed on a subgrade to support the traffic load and distribute it to the roadbed.

PAY ITEM

Synonymous with *Contract Item*.

PLANS

The approved plans, profiles, typical roadway sections, appropriate standard drawings, supplemental plans, and working drawings, or exact reproductions thereof, that show the location, dimensions, and details of the work to be done, and that are a part of the contract.

PREBID CONFERENCE

A conference held before bids are accepted on a project at which representatives of the Department will provide information, and accept and answer questions from interested parties.

PROJECT

The specific section of the highway together with all appurtenances and construction to be performed thereon under the contract.

PROJECT SPECIAL PROVISIONS

Special provisions peculiar to the project and not otherwise thoroughly or appropriately set forth in the standard specifications or plans.

PROPOSAL

The electronic or paper document provided by the Department that the bidder uses to develop his electronic or paper offer to perform the work at designated bid prices.

RIGHT OF WAY

The land area shown on the plans as right of way to be furnished by the Department of Transportation within which the project is to be constructed.

ROAD

Synonymous with *Highway* and *Street*.

ROADBED

The graded portion of a highway usually considered as the area between the intersections of top and side slopes, upon which the base course, surface course, shoulders, and medians are constructed.

ROADSIDE

A general term denoting the area within the limits of the right of way adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be considered roadside.

ROADWAY

The portion of a highway within limits of construction.

SECTION

A numbered chapter of the standard specifications.

SHOULDER

The portion of the roadway adjacent to the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

SIDEWALK

That portion of the roadway primarily constructed for pedestrian traffic.

SKEW ANGLE

The angle between the centerline of the project and the centerline of a pipe, culvert, bridge pier, bent, abutment, or other drainage feature, measured to the right of the project centerline facing in the direction of progressing stations.

SPECIAL PROVISIONS

Project special provisions and standard special provisions taken together as one body of special provisions.

SPECIFICATIONS

The general term comprising all the directions, provisions, and requirements contained or referred to in the standard specifications, including the supplemental specifications, together with such additional directions, provisions, and requirements that may be added or adopted as special provisions.

STANDARD SPECIAL PROVISIONS

Special directions or requirements not otherwise thoroughly or appropriately set forth in the standard specifications and that are peculiar to a selected group of projects.

STANDARD SPECIFICATIONS

The general term comprising all the directions, provisions, and requirements contained or referred to in this book entitled *Standard Specifications for Roads and Structures*, and in any subsequent revisions or additions to such book that are issued under the title *Supplemental Speci*fication*s*.

STATE

The State of North Carolina.

STATION

A station, when used as a term of measurement, will be 100 linear feet measured horizontally. When used as a location, it will be a designated point on the project.

STREET

Synonymous with *Highway* and *Road*.

SUBCONTRACTOR

An individual, partnership, firm, joint venture, L.L.C. or corporation to whom the Contractor, with the written consent of the Engineer, sublets any part of the contract.

SUBGRADE

That portion of the roadbed prepared as a foundation for the pavement structure including curb and gutter. On portions of projects that do not include the construction of a base course or pavement, the presence of the subgrade will not be recognized during the life of such contract.

SUBSTRUCTURE

All of that part of the structure below the bearings of simple and continuous spans, spans, skew back of arches and tops of footings of rigid frames, together with the backwalls, and wingwalls.

SUCCESSFUL BIDDER

The bidder awarded a contract.

SUPERINTENDENT

The representative of the Contractor authorized to supervise and direct the construction for the Contractor and to receive and fulfill directions from the Engineer.

SUPERSTRUCTURE

All of the part of the structure exclusive of the substructure.

SUPPLEMENTAL AGREEMENT

A written agreement between the Contractor and the Department of Transportation covering amendments to the contract.

SUPPLEMENTAL SPECIFICATIONS

General revisions or additions to this book of standard specifications that are issued under the title of *Supplemental Specifications*, and that shall be considered as part of the standard specifications, or specifications, regulations, standards, or codes referenced in the contract.

SURETY

A corporate bonding company furnishing the bid bond or furnishing the contract payment and performance bonds.

TEMPORARY CONSTRUCTION EASEMENT

A temporary right, owned by the Department of Transportation, in a parcel of land owned by a third party outside the highway right of way, for the use of the Department of Transportation during the construction and that reverts to the third party on completion of construction.

THROUGH TRAFFIC

Traffic that can reach its destination by a route or routes other than the facility under construction.

TIME OF AVAILABILITY

That time established as set forth in the special provisions, by which it is anticipated that sufficient work sites within the project limits will be available for the Contractor to begin his controlling operations.

TOTAL AMOUNT BID

Same as total price bid. The total amount bid will be considered to be the correct sum total obtained by adding together the amounts bid for every item in the proposal other than items which are authorized alternates to those items for which an amount bid has been established.

UNBALANCED BID

A bid that includes any unbalanced bid price.

UNBALANCED BID PRICE

A unit or lump sum bid price that does not reflect reasonable actual costs that the bidder anticipates for the performance of the item in question along with a reasonable proportionate share of the bidder's anticipated profit, overhead costs, and other indirect costs.

WORK

Work shall mean the furnishing of all labor, materials, equipment, and incidentals necessary or convenient to the successful completion of the project, or any part, portion, or phase thereof, and the carrying out of all duties and obligations imposed by the contract.

WORKING DRAWINGS

Stress sheets, shop drawings, erection drawings, falsework drawings, cofferdam drawings, catalog cuts, or any other supplementary drawings or similar data that the Contractor is required to submit to the Engineer for review and/or approval.

SECTION 102
BIDDING REQUIREMENTS AND CONDITIONS

102-1 INVITATION TO BID

After the advertisement has been made, an invitation to bid will be mailed to known prequalified contractors and any other contracting firms, material suppliers, and other interested parties who have requested they be placed on the invitation to bid mailing list informing them that bids will be received for the construction of specific projects. Such invitation will indicate the contract identification number, length, locations, and descriptions; a general summary of the items and approximate quantities of work to be performed; and the time and place for the public opening and reading of the bids received.

Information concerning the cost and availability of plans and proposals will also be indicated in the invitation to bid.

All projects will be advertised in daily newspapers throughout the state prior to the bid opening.

102-2 CONTRACTOR PREQUALIFICATION

Contractors desiring to perform work on NCDOT projects shall prequalify with the Department. Upon prequalification, Contractors will be placed on the Department's Prequalified Bidders List and/or the Approved Subcontractors List, depending on the application submitted. The requirements for prequalification are as follows:

(A) BIDDER PREQUALIFICATION

(1) Applicant shall submit a completed NCDOT Bidder Experience Questionnaire along with any additional supporting information requested by the Department, as noted in the Experience Questionnaire package. Additional requirements for prequalification will be set forth in the contract.

(2) Applicant shall demonstrate that he has sufficient ability and experience in related highway construction projects to perform the work specified in NCDOT contracts, including the type and dollar value of previous contracts.

(3) Applicant shall demonstrate a history of successful performance and completion of projects in a timely manner, subject to contract time adjustments.

(4) Applicant shall demonstrate the financial ability to furnish bonds as specified in G.S. 44A-26.

(5) Applicant shall demonstrate sufficient and readily available equipment to perform highway construction contracts in a timely manner.

(6) Applicant shall demonstrate sufficient available experienced personnel to perform highway construction contracts. The identities and qualifications of both management and labor work force shall be provided.

(7) Applicant shall provide names and addresses of persons for whom the firm has performed related work. Responses from the references shall be on Department of Transportation forms and shall be received by the Department prior to evaluating the request for prequalification.

(8) Applicant shall provide any information requested concerning the corporate and operational management structure of the company, the identity of persons or entities owning stock or other equity interest in the company, and the relationship between the applicant and any other company prequalified with the Department or applying for prequalification.

(9) Applicant shall demonstrate, at the time of application for prequalification, the financial capacity to successfully complete projects containing the work types they so designate.

(10) Applicant shall provide further information as may be required to determine that the firm is a responsible bidder.

(11) Applicant shall submit a completed Pre-bid Non-collusion Affidavit and Debarment Certification, in accordance with Article 102-10. These forms can be found on the Department's website.

(12) Applicant shall submit a completed Safety Index Rating Form with the Questionnaire and annually thereafter. Details regarding the Safety Index are discussed later in Article 102-2(C). This form may be obtained by contacting the State Contractual Services Engineer or from the Department's website.

Bidders shall renew annually and requalify every 3 years. See Article 102-2(D) Renewal / Requalification for details.

The Bidder Experience Questionnaire shall be completed in its entirety and signed by an officer of the firm. The officer's signature shall be notarized. In addition to submitting the Experience Questionnaire form as set forth above, the prospective bidder shall submit supporting information in a format of his choosing to address the requirements listed above.

The prospective bidder shall file all required statements and documents with the State Contractual Services Engineer no less than 4 weeks prior to a given letting for their bid to be considered. A bid shall not be opened unless all prequalification requirements have been met by the bidder and have been found acceptable by the Engineer.

(B) SUBCONTRACTOR PREQUALIFICATION

Contractors who have been approved to be placed on the Prequalified Bidders' List as noted above may also perform work for the Department as a subcontractor and need not apply further. Subcontractors will not be placed on the Prequalified Bidders' List unless they submit through the Prequalification process.

(1) Applicant shall submit a completed NCDOT Subcontractor Experience Questionnaire along with any additional supporting information requested by the Department. Additional requirements for prequalification will be set forth in the contract.

(2) Applicant shall demonstrate sufficient ability and experience in related construction projects to perform the work specified in NCDOT contracts, including the type of previous contracts.

(3) Applicant shall demonstrate sufficient and readily available equipment to perform highway construction contracts in a timely manner.

(4) Applicant shall submit a completed Safety Index Rating Form with the Questionnaire and annually thereafter. Details regarding the Safety Index are discussed later in Subarticle 102-2(C). This form may be obtained by contacting the State Contractual Services Engineer or from the Department's website.

(5) Applicant shall provide further information as may be required.

Subcontractors shall renew annually and requalify every 3 years. See Subarticle 102-2(D) Renewal/Requalification for details.

Prospective subcontractors may request a NCDOT Subcontractor Experience Questionnaire and a Safety Index Rating Form from the State Contractual Services Engineer. The Safety Index Rating Form is included in the Subcontractor Experience Questionnaire and can also be found at the Department's website:

The Subcontractor Experience Questionnaire shall be completed in its entirety. In addition to submitting the Experience Questionnaire as set forth above, the prospective subcontractor shall submit supporting information in a format of their choosing to address the requirements listed above.

The prospective bidder shall file all required statements and documents with the State Contractual Services Engineer no less than 4 weeks prior to beginning work. A subcontractor will not be allowed to begin work until all prequalification requirements have been met by the subcontractor and have been found acceptable by the Engineer.

Upon determination by the Department that all prequalification requirements have been met, the applicant will be assigned a Vender Identification Number. This Number will thereafter be assigned to all applicants for prequalification or requalification which the Department determines are under sufficient common ownership and management control to warrant prequalification as a single entity. This determination by the Department shall be based on the information submitted with the Experience Questionnaire, annual review of indices, and any other information obtained by the Department.

(C) SAFETY INDEX

The Department will conduct a review of each firm's Safety Index. To be prequalified, each firm shall maintain a satisfactory safety index. An overall safety index equal to or greater than 60 is considered satisfactory. In addition, an index between 60 and 69 may be considered marginal and may result in an in-depth safety audit of a firm's safety practices. An overall safety index equal to or less than 59 is considered unsatisfactory and will prohibit prequalification of new firms until said firms meet the requirements described below.

A score of 59 or less for requalifying firms will result in disciplinary action as follows. The Engineer may require the Contractor to state in writing the reason(s) for the unsatisfactory rating and produce such supporting data as may be necessary to evaluate the circumstances surrounding the rating. When the Contractor cannot provide justification to raise the unsatisfactory safety index, the Engineer may invoke one or more of the following sanctions:

(1) Removal of the firm from the Prequalified Bidders' List and/or the Approved Subcontractors List

(2) Placement of the firm on probation for up to two years

(3) Auditing of the firm's safety practices

(4) Giving a written warning to correct any safety deficiencies

Firms not approved or disqualified to bid or perform subcontract work due to an unsatisfactory safety index will not be approved or reinstated to bid or perform subcontract work until they can provide adequate evidence that all safety deficiencies have been corrected to the satisfaction of the Engineer.

(D) RENEWAL AND REQUALIFICATION

Renewal of bidders shall occur annually on or before the firm's anniversary, which is based upon the prequalification expiration date. Renewal shall consist of submitting an updated Safety Index, any other required indices, and the non-collusion documents mentioned earlier in Subarticle 102-2(A). Bids of firms who fail to submit these documents by their anniversary date will not be considered until such time as these documents are received and approved by the Engineer. The Engineer may also review performance related issues when considering bidders for renewal.

Renewal of subcontractors shall occur annually on or before the firm's anniversary, which is based upon the prequalification expiration date. Renewal shall consist of submitting an updated Safety Index and any other required indices. Subcontractors who fail to submit these documents by their anniversary date will not be allowed to begin work on any new contracts until these documents are received and approved by the Engineer.

Requalifying of bidders and subcontractors shall occur every 3 years. Those requalifying may request their respective NCDOT Experience Questionnaire form, a Safety Index Rating Form, and any other index rating forms from the State Contractual Services Engineer. Requalifying bidders shall also submit their non-collusion documents as shown in Subarticle 102-2(A). The Safety Index Rating Form is included in the Experience Questionnaire and can be found on the Department's website.

The requalifying contractor shall file all required statements and documents with the State Contractual Services Engineer no less than 4 weeks prior to a given letting for their bid to be considered. Following the expiration date, a bid will not be opened unless all requalification requirements have been met by the bidder and have been found acceptable by the Engineer. Also, following the expiration date, a subcontractor may not begin any new work unless all requalification requirements have been met by the subcontractor and have been found acceptable by the Engineer.

102-3 PROPOSALS AND PLAN HOLDER LISTS

The bidder shall purchase a proposal for each project for which he intends to submit a bid on NCDOT projects advertised through the Raleigh Central Office. The prospective bidder will be required to pay *the Department of Transportation* the sum stated in the invitation to bid for each copy of the proposal and each set of plans purchased.

This proposal will state the location of the contemplated construction and will show a schedule of contract items with the approximate quantity of each of these items for which bid prices are invited. It will set forth the date and time for the opening of bids. The proposal will also include any special provisions or requirements that vary from or are not contained in the plans or standard specifications.

The plans, standard specifications, and other documents designated in the proposal shall be considered a part of the proposal whether or not attached.

The names and identity of corporations, firms, partnerships, individuals, L.L.C. or joint ventures who have requested plans or proposals for the purposes of bidding shall be made public, except that a potential bidder who obtains a set of plans/proposals may, at the time of ordering, request that his name remain confidential.

(A) Paper bids The proposal will also include the printed contract forms and signature sheets for execution by both parties to the contract. In the event the bidder is awarded the contract, execution of the bid by the bidder is considered the same as execution of the contract.

All papers bound with the proposal are necessary parts thereof and shall not be detached, taken apart, or altered.

(B) Electronic bids The bidder shall bid in accordance with the applicable sections of Article 102-8B.

102-4 COMBINATION BIDS

If the Department so elects, proposals may be issued for projects in combination or separately, so that bids may be submitted either on the combination or on separate units of the combination. The right is reserved to make awards on combination bids or separate bids to the best advantage of the Department. No combination bids, other than those specified by the Department in the proposal will be considered.

102-5 INTERPRETATION OF QUANTITIES IN PROPOSAL

The quantities appearing in the proposal are approximate only and are to be used for the comparison of bids. Payment to the Contractor will be made in accordance with the terms of the contract.

When revisions in the plans are made by the Engineer that affect the quantities shown for lump sum items, adjustment in compensation may be made under the provisions of Articles 104-3 or 104-7.

102-6 EXAMINATION OF PLANS, SPECIFICATIONS, CONTRACT, AND SITE OF WORK

The bidder shall examine carefully the site of the work contemplated, the plans and specifications, and the proposals and contracts therefor. The submission of a bid shall be conclusive evidence that the bidder has investigated and is satisfied as to the conditions to be encountered; as to the character, quality, and scope of work to be performed, the quantities of materials to be furnished, and as to the conditions and requirements of the proposal plans, and contract under which his bid is offered.

A bidder or contractor is cautioned to make such independent investigation and examination as he deems necessary to satisfy himself as to conditions to be encountered in the performance of the work and with respect to possible local material sources, the quality and quantity of material available from such property, and the type and extent of processing that may be required in order to produce material conforming to the requirements of the contract.

102-7 SUBSURFACE INVESTIGATION REPORT

If a subsurface investigation report is available on this project, a copy may be obtained by the plan holders upon request.

The subsurface investigation on which it is based was made for the purpose of study, planning, and design, and not for construction or pay purposes. The various field boring logs, rock cores, and soil test data available may be reviewed or inspected in Raleigh at the office of the Geotechnical Unit. Neither the subsurface investigation report nor the field boring logs, rock cores, or soil test data is part of the contract.

General soil and rock strata descriptions and indicated boundaries are based on a geotechnical interpretation of all available subsurface data and may not necessarily reflect the actual subsurface conditions between borings or between sampled strata within the borehole. The laboratory sample data and the in situ (in-place) test data can be relied on only to the degree of reliability inherent in the standard test method. The observed water levels or soil moisture conditions indicated in the subsurface investigations are as recorded at the time of the investigation. These water levels or soil moisture conditions may vary considerably with time according to climatic conditions including temperature, precipitation, and wind, as well as other nonclimatic factors.

The bidder or contractor is cautioned that details shown in the subsurface investigation report are preliminary only; the final design details may be different. For bidding and construction purposes refer to the contract for final design information on this project. The Department does not warrant or guarantee the sufficiency or accuracy of the investigation made, nor the interpretations made or opinions of the Department as to the type of materials and conditions that may be encountered. The bidder or contractor is cautioned to make such independent subsurface investigations, as he deems necessary to satisfy himself as to conditions to be encountered on this project. The Contractor shall have no claim for additional compensation or for an extension of time for any reason resulting from the actual conditions encountered at the site differing from those indicated in the subsurface investigation.

102-8 PREPARATION AND SUBMISSION OF BIDS

All bids shall be prepared and submitted in accordance with the following requirements.

The bidder shall submit a unit or lump sum price for every item in the proposal other than items that are authorized alternates to those items for which a bid price has been submitted.

An amount bid shall be entered in the proposal for every item on which a unit price has been submitted. As an exception to the above, when the proposal permits a bidder to submit a bid on only a portion of the work covered by the entire proposal, the bidder shall then submit a unit or lump sum price for every item constituting that portion of the work on which the bidder has elected to place a bid other than items that are authorized alternates to those items for which a bid price has been submitted.

In the case of lump sum items, the price shall be written in figures in the Amount Bid column in the proposal.

The bid shall not contain any unauthorized additions, deletions, or conditional bids.

The bidder shall not add any provision reserving the right to accept or reject an award, or to enter into a contract pursuant to an award.

The bid shall not be an unbalanced bid.

(A) Paper Bids shall also meet the following:

(1) The proposal provided by the Department shall be used and shall not be taken apart or altered. The bid shall be submitted on the same proposal that has been furnished to the bidder by the Department.

The bid shall be accompanied by a bid bond on the form furnished by the Department or by a bid deposit. The bid bond shall be completely and properly executed in accordance with the requirements of Article 102-11. The bid deposit shall be a certified check or cashier check in accordance with Article 102-11.

(2) All entries including signatures shall be written in ink.

(3) The unit prices shall be rounded off by the bidder to contain no more than 4 decimal places.

(4) An amount bid shall be entered in the proposal for every item on which a unit price has been submitted. The amount bid for each item other than lump sum items shall be determined by multiplying each unit bid price by the quantity for that item, and shall be written in figures in the Amount Bid column in the proposal.

(5) In the case of lump sum items, the price shall be written in figures in the Amount Bid column in the proposal.

(6) The total amount bid shall be written in figures in the proper place in the proposal. The total amount bid shall be determined by adding the amounts bid for each item.

(7) Changes in any entry shall be made by marking through the entry in ink and making the correct entry adjacent thereto in ink. A representative of the bidder shall initial the change in ink.

(8) The bid shall be properly executed. In order to constitute proper execution, the bid shall be executed in strict compliance with the following:

(a) If a bid is by an *individual*, it shall show the name of the individual and shall be signed by the individual with the word *Individually* appearing under the signature. If the individual operates under a firm name, the bid shall be signed in the name of the individual doing business under the firm name.

(b) If the bid is by a corporation, the President, Vice President, or Assistant Vice President shall execute it in the name of the corporation. The Secretary or Assistant Secretary shall attest it. The seal of the corporation shall be affixed. If the bid is executed on behalf of a corporation in any other manner than as above, a certified copy of the minutes of the Board of Directors of said corporation authorizing the manner and style of execution

and the authority of the person executing shall be attached to the bid or shall be on file with the Department.

(c) The bid is made by a partnership, it shall be executed in the name of the partnership by one of the general partners.

(d) If the bid is made by a limited liability company, it shall be signed by the manager and notarized.

(e) If the bid is a joint venture, it shall be executed by each of the joint venturers in the appropriate manner set out above. In addition, the execution by the joint venturers shall appear below their names.

(f) The bid execution shall be notarized by a notary public whose commission is in effect on the date of execution. Such notarization shall be applicable both to the bid and to the non-collusion affidavit that is part of the signature sheets.

(9) The bid shall be placed in a sealed envelope and shall have been delivered to and received by the Department prior to the time specified in the invitation to bid.

(B) Electronic bids shall also meet the following:

The Department will not be responsible if a bidder cannot submit his bid to Bid Express® and claims will not be accepted for such.

(1) Obtain an account and valid Digital Signature from Bid Express® in order to bid electronically.

(2) Article 103-2 Correction of Bid Errors will not apply to Electronic Bidding.

(3) The bid shall be accompanied by an electronic bid bond or by a bid deposit. The bid bond shall be completely and properly executed in accordance with the requirements of Article 102-11. The bid deposit shall be a certified check or cashier check in accordance with Article 102-11.

(4) Debarment Certification and Non–Collusion Affidavit - The bidder shall provide a debarment certification in accordance with Articles 102-2 and 102-10.

(5) All addenda and attachments will be considered part of the bid.

(6) All bids shall be submitted with an electronically affixed digital signature. For the purpose of this specification, affixing a digital ID to the bid shall be the equivalent of signing before a notary public.

(7) By submitting an electronic bid, the bidder certifies that he has read, understands, accepts, acknowledges and agrees to comply with all statements, conditions and Specifications in the electronic bid submittal.

(8) Bids will be decrypted, opened, printed to paper and read publicly in accordance with Subarticle 102-14.

(9) The Contractor shall submit a fully executed Execution of Contract, signature sheet, and payment and performance bonds within 14 calendar days of receipt of award letter in accordance with Article 102-10.

102-9 BLANK

102-10 NON-COLLUSION AFFIDAVIT AND DEBARMENT CERTIFICATION

(A) General Prime contractors and lower tier participants in each transaction involving public funds shall execute a non-collusion certification and debarment certification. Transactions that require certifications from lower tier participants are:

(1) Transactions between a prime contractor and a person, other than for a procurement contract, for goods or services, regardless of type.

(2) Procurement contracts for goods and services, between a prime contractor and a person, regardless of type, expected to equal or exceed the Federal small purchase threshold fixed at 10 U.S.C. 2304(g) [currently twenty-five thousand dollars ($25,000)] under a prime contract.

(3) Procurement contracts for goods or services between a prime contractor and a person, regardless of the amount, under which that person will have a critical influence on or substantive control over the transaction. Such persons include, but are not limited to, bid estimators and contract managers.

The certifications for both the prime contractor and the lower tier participants shall be on a form furnished by the Department of Transportation to comply with Federal Highway Administration requirements, as published in 49 CFR Part 29. The prime contractor is responsible for obtaining the certifications from the lower tier participants and is responsible for keeping them as part of the contract records.

(B) Non-collusion Affidavit In compliance with applicable Federal and State laws and regulations, each and every bidder shall furnish the Department with an affidavit certifying that the bidder has not entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with his bid on the project. The affidavit shall also conclusively indicate that the bidder intends to do the work with its own bonafide employees or subcontractors and is not bidding for the benefit of another contractor.

(C) Debarment Certification In compliance with applicable Federal and State laws and regulations, each and every bidder shall furnish the Department with a debarment certification, stating that he is not debarred, or if he is debarred, an explanation shall be included. The explanation will not necessarily result in denial of participation in a contract. Failure to furnish a certification or an explanation will be grounds for rejection of a bid. If the prequalified bidder's status changes, he shall immediately submit a new fully executed debarment certification with an explanation of the change.

Failure to have a fully executed non-collusion affidavit and debarment certification on file in the Contractual Services Office prior to submitting bids will cause those bids to be non-responsive.

(1) **Paper Bid** Execution of Bid, Noncollusion Affidavit and Debarment Certification forms will be included in the Proposal as part of the signature sheets. Execution of the signature sheets will also constitute execution of the

bid, non-collusion affidavit and the debarment certification. The signature sheets shall be notarized.

(2) **Electronic Bids** The prequalified bidder shall have a fully executed Non-Collusion Affidavit and Debarment Certification on file in the Contractual Services Office prior to submitting his bid. Non-collusion and debarment certification forms may be downloaded from the Department's website.

The bidder shall provide a debarment certification in the electronic bid submittal. If a bidder cannot provide the debarment certification required, he shall provide an explanation in the Bid Express® miscellaneous folder within the .ebs file.

After the successful bidder receives the award letter, he shall submit a fully executed Execution of Contract, Non-Collusion Affidavit and Debarment Certification signature sheet, within 14 calendar days of receipt of the award letter.

102-11 BID BOND OR BID DEPOSIT

Each bid shall be accompanied by a corporate bid bond or a bid deposit of a certified or cashiers check in the amount of at least 5% of the total amount bid for the contract. When a bid is secured by a bid deposit (certified check or cashiers check), the execution of a bid bond will not be required.

If the bidder has failed to meet all conditions of the bid bond and the Department has not received the amount due under the bid bond, the bidder may be disqualified from further bidding as provided in Article 102-16.

No bid will be considered or accepted unless accompanied by one of the foregoing securities. The bid bond shall be executed by a Corporate Surety licensed to do business in North Carolina and the certified check or cashiers check shall be drawn on a bank or trust company insured by the Federal Deposit Insurance Corporation and made payable to the *Department of Transportation* in an amount of at least 5% of the total amount bid for the contract. The condition of the bid bond or bid deposit is: the Principal shall not withdraw its bid within 60 days after the opening of the same, and if the Board of Transportation shall award a contract to the Principal, the Principal shall within 14 calendar days after the notice of award is received by him give, payment and performance bonds with good and sufficient surety as required for the faithful performance of the contract and for the protection of all persons supplying labor and materials in the prosecution of the work; in the event of the failure of the Principal to give such payment and performance bonds as required, then the amount of the bid bond shall be immediately paid to the Department as liquidated damages, or, in the case of a bid deposit, the deposit shall be forfeited to the Department.

Withdrawal of a bid due to a mistake made in the preparation of the bid, where permitted by Article 103-3, shall not constitute withdrawal of a bid as cause for payment of the bid bond or forfeiture of the bid deposit.

When a bid is secured by a bid bond, the bid bond shall be on the form furnished by the Department. The bid bond shall be executed by both the bidder and a Corporate

Surety licensed under the laws of North Carolina to write such bonds. The execution by the bidder shall be in the same manner as required by Article 102-8 for the proper execution of the bid. The execution by the Corporate Surety shall be the same as is provided for by Article 102-8(A)(8)(b), for the execution of the bid by a corporation. The seal of the Corporate Surety shall be affixed to the bid bond. The bid bond form furnished is for execution of the Corporate Surety by a General Agent or Attorney in Fact. A certified copy of the Power of Attorney shall be attached if the bid bond is executed by a General Agent or Attorney in Fact. The Power of Attorney shall contain a certification that the Power of Attorney is still in full force and effect as of the date of the execution of the bid bond by the General Agent or Attorney in Fact. If the bid bond is executed by the Corporate Surety by the President, Vice President, or Assistant Vice President, and attested to by the Secretary or Assistant Secretary, then the bid bond form furnished shall be modified for such execution, instead of execution by the Attorney in Fact or the General Agent.

(A) Electronic Bids An electronic corporate surety bid bond for at least 5 percent of the total amount bid shall accompany each electronic bid, or the Contractor may submit a certified check or cashier's check in lieu of an electronic bid bond. The certified check or cashier's check shall be for at least 5 percent of the total amount bid; shall be received by 5 p.m. the last business day before the bid letting, and shall be delivered to the Contract Officer at the address shown in the Invitation to Bid.

Contact either or both of the following bond management companies in order to acquire the necessary service to submit an electronic bid bond.

(1) Surety 2000 or
100 Terminal Dr., Plainview, NY 11805, 1-800-660-3263

(2) Surepath
InSure Vision Technologies, LLC
5170 Sepulveda Blvd., Ste. 200, Sherman Oaks, CA 91403, 1-818 783-3460

102-12 DELIVERY OF BIDS

(A) Paper Bids shall be delivered prior to the time and place specified in the contract. Bids received after such time will not be accepted and will be returned to the bidder unopened.

(B) Electronic Bids shall be submitted via approved Department electronic bidding software in accordance with Article 102-8.

102-13 WITHDRAWAL OR REVISION OF BIDS

(A) Paper Bid A bidder may, without prejudice to himself, withdraw a paper bid after it has been delivered to the Department, provided the request for such withdrawal is made in writing, to the Contract Officer before the date and time set for the opening of bids. The bidder may then submit a revised bid provided it is received prior to the time set for opening of bids.

Only those persons authorized to sign bids under the provisions of Article 102-8, Item 8, shall be recognized as being qualified to withdraw a bid.

(B) Electronic Bid An electronic bid may be changed and resubmitted as many times as desired prior to the advertised bid opening time specified in the Invitation to Bid. The latest time stamped electronically submitted bid prior to the advertised bid opening time will constitute the bid.

Withdrawal of a bid after the date and time set for the opening of bids will be permitted only in accordance with Article 103-3.

102-14 RECEIPT AND OPENING OF BIDS

A bid will be received and opened from any bidder who:

(A) Is prequalified in accordance with the provisions of Article 102-2, and

(B) Has delivered the bid to the place indicated in the contract prior to the time indicated in the invitation to bid.

(1) **Paper Bids** will be opened and read publicly at the time and place indicated in the invitation to bid. Bidders, their authorized agents, and other interested parties are invited to be present.

(2) **Electronic Bids** will be decrypted, opened, printed to paper and read publicly at the time and place specified in the invitation to bid.

A bid received from a bidder who has not complied with the above requirements will be returned to the Bidder unopened and under no circumstances will be considered for award.

In the event of technical difficulties or adverse weather conditions, the Department reserves the right to postpone the reading of bids past the advertised bid opening time and date.

102-15 REJECTION OF BIDS

Any bid submitted that fails to comply with any of the requirements of Article 102-8, 102-10 or 102-11 shall be considered irregular and may be rejected.

Irregularities due to apparent clerical errors and omissions may be waived in accordance with Article 103-2.

Any bid including any unit or lump sum bid price that is unbalanced to the potential detriment of the Department will be considered irregular and may be rejected. In the event the Board determines it is in the best public interest to accept such irregular bid, it may award the contract based on such bid subject to the requirements of Subarticle 109-4(C).

All bidders shall comply with all applicable laws regulating the practice of general contracting as contained in *Chapter 87 of the General Statutes of North Carolina* which requires the bidder to be licensed by the N.C. Licensing Board for Contractors when bidding on any non-federal aid project where the bid is $30,000 or more, except for certain specialty work as determined by the licensing board. Bidders shall also comply with all other applicable laws regulating the practices of electrical, plumbing, heating and air conditioning and refrigeration contracting as contained in *Chapter 87 of the General Statutes of North Carolina*. Notwithstanding the limitations on bidding, the bidder who is awarded any project shall comply with *Chapter 87 of the General Statutes of North Carolina* for licensing requirements within 60 calendar days of bid opening, regardless of funding sources.

In addition to the above, any bids for contracts not funded with any Federal funds that are submitted by any bidder who has failed to obtain the appropriate General Contractor's license, as required by Chapter 87 of the General Statutes of North Carolina, shall be considered non-responsive and will not be considered for award.

The right to reject any and all bids shall be reserved to the Board.

102-16 DISQUALIFICATION OF BIDDERS

Any one of the following causes may be justification for disqualifying a Contractor from further bidding until he has applied for and has been requalified in accordance with Article 102-2:

(A) Unsatisfactory progress in accordance with Article 108-8.

(B) Being declared in default in accordance with Article 108-9.

(C) Uncompleted contracts which, in the judgment of the Engineer, might hinder or prevent the timely completion of additional work if awarded.

(D) Failure to comply with prequalification requirements.

(E) The submission of more than one bid for the same contract by an individual, partnership, joint venture, L.L.C. or corporation prequalified under the same prequalification number.

(F) Evidence of collusion among bidders. Each participant in such collusion will be disqualified.

(G) Failure to furnish a non-collusion affidavit upon request.

(H) Failure to comply with Article 108-6.

(I) Failure to comply with a written order of the Engineer as provided in Article 105-1 if in the judgment of the Engineer, such failure is of sufficient magnitude to warrant disqualification.

(J) Failure to satisfy the Disadvantaged Business Enterprise requirements of the project special provisions.

(K) The Department has not received the amount due under a forfeited bid bond or under the terms of a performance bond.

(L) Failure to submit the documents required by Article 109-10 within 60 days after request by the Engineer.

(M) Failure to return overpayments as directed by the Engineer.

(N) Failure to maintain a satisfactory safety index as required by Article 102-2.

(O) Recruitment of Department employees for employment as prohibited by Article 108-5.

(P) False information submitted on any application, statement, certification, reports, records and/or reproduction.

Conviction of any employee of the company, of any applicable state or federal law, may be fully imputed to the business firm with which he is or was associated or by whom he was employed or with the knowledge or approval of the business firm or there after ratified by it.

(Q) Being debarred from performing work with other city, state, and federal agencies.

(R) Failure to perform guaranty work within the terms of the contract.

Upon a determination that a contractor should be disqualified for one or more of the reasons listed above, the Department may, at its discretion, remove all entities prequalified under the same Prequalification Number.

SECTION 103

AWARD AND EXECUTION OF CONTRACT

103-1 CONSIDERATION OF BIDS

After the bids are opened and read, they will be compared on the basis of the summation of the products of the quantities shown in the bid schedule by the unit bid prices. The results of such comparisons will be immediately available to the public. In the event of errors, omissions, or discrepancies in the bid prices, corrections to the bid prices will be made in accordance with the requirements of Article 103-2. Such corrected bid prices will be used for the comparison and consideration of bids.

The right is reserved to reject any or all bids, to waive technicalities, to request the low bidder to submit an up-to-date financial and operating statement, to advertise for new bids, or to proceed to do the work otherwise, if in the judgment of the Board, the best interests of the State will be promoted thereby.

103-2 CORRECTION OF BID ERRORS

(A) Paper Bids

(1) General

The provisions of this article shall apply in waiving irregularities and correcting apparent clerical errors and omissions in the unit bid price and the amount bid for bid items.

(2) Omitted Unit Bid Price--Amount Bid Completed--Quantity Bid on Is One Unit

In the case of a bid item for which the amount bid is completed, but the unit bid price is omitted and the quantity shown in the proposal for the bid item is only one unit, the unit bid price shall be deemed to be the same as the amount bid for that bid item and shall constitute the contract unit price for that bid item.

(3) Omitted Unit Bid Price--Amount Bid Completed--Quantity Bid on Is More Than One Unit

In the case of a bid item for which the amount bid is completed (extension of the unit bid price by the quantity) but the unit bid price is omitted and the quantity shown in the proposal for the bid item is more than one unit, the unit bid price shall be deemed to be the amount derived by dividing the amount bid for that item by the quantity shown in the proposal for that bid item and shall constitute the contract unit price for that bid item.

(4) **Discrepancy in the Unit Bid Price and the Amount Bid**

In the case of a bid item in which there is a discrepancy between the unit bid price and the extension for the bid item (amount bid), the unit bid price shall govern.

As an exception to the above, on bids for contracts not funded with any Federal funds, the extension for the bid item (amount bid) shall govern when the discrepancy consists of an obvious clerical mistake in the unit bid price consisting of the misplacement of a decimal point. The correction to the unit bid price will be made only when the following two conditions are met:

(a) The corrected unit bid price multiplied by the quantity equals the amount bid for the bid item.

(b) The corrected unit bid price is closer to the average of the engineer's estimate and the individual bids for the contract item than the uncorrected unit bid price.

(5) **Omitted Unit Bid Price and Omitted Amount Bid--Deemed Zero Bid**

The provisions of this subarticle shall apply only to bids for contracts not funded with any Federal funds.

In the case of omission of the unit bid price and the omission of the amount bid for any one item, and also in the case of the omission of the amount bid where a lump sum price is called for, the amount bid and the unit bid price shall be deemed to be zero where the value of the omitted amount bid is 1 percent or less of the total amount bid for the entire project (excluding the omitted item). The value of the omitted amount bid will be derived by determining the average of the engineer's estimate and the individual bids for that contract item.

Where the unit bid price is deemed to be zero as provided in this subarticle, such zero unit bid price shall constitute the contract unit price for the affected bid item.

Where the amount bid for a lump sum bid item is deemed to be zero as provided in this subarticle, such zero amount bid shall constitute the contract lump sum price for that bid item.

This subarticle shall not apply to the bid item for Mobilization.

(6) Unit bid prices containing more than four (4) decimal places.

In the case of a Bid Item for which the amount bid contains more than four (4) decimal places for the Unit Bid Price, only the whole number and the first four (4) decimal places shall constitute the Contract Unit Price for that Bid Item.

(B) Electronic Bids

(1) Enter a unit price in schedule of items. Totals will be generated automatically.

(2) Data incorrectly entered will not be recognized and the bid item will remain blank until entered correctly.

(3) Enter no more than 4 decimal places for unit price.

(4) Zero will be considered a valid bid. Do not enter zero (0) in any unit price field unless zero is the intended bid for that item.

(5) When the proposal includes alternates, the bidder may bid only one alternate or may bid multiple alternates as shown in the proposal. Expedite® will determine the lowest total price based on the alternate(s) bid. Any bid price entered, including zero as shown in (4) above will be considered a valid bid.

103-3 WITHDRAWAL OF BIDS--MISTAKE

(A) Criteria for Withdrawal of Bid:

The Department of Transportation may allow a bidder submitting a bid pursuant to G.S. 136-28.1 for construction or repair work to withdraw his bid after the scheduled time of bid opening upon a determination that:

(1) A mistake was in fact made in the preparation of the bid.

(2) The mistake in the bid is of a clerical or mathematical nature and not one of bad judgment, carelessness in inspecting the work site, or in reading the contract.

(3) The mistake is found to be made in good faith and was not deliberate or by reason of gross negligence.

(4) The amount of the error or mistake is equal to or greater than 3 percent of the total amount bid.

(5) The notice of mistake and request for withdrawal of the bid by reason of the mistake is communicated to the Engineer within 48 hours after the scheduled time of bid opening. Upon proper notification of a mistake and request for withdrawal of bid, the bidder shall submit within 48 hours written notice of mistake accompanied by copies of bid preparation information to the Engineer. The notification of a mistake, request for withdrawal of bid and copies of bid preparation information shall be submitted to the State Contract Officer or Engineer.

(6) The Department of Transportation will not be prejudiced or damaged except for the loss of the bid.

(B) Hearing by the Engineer

If a bidder files a notice of mistake along with a request to withdraw his bid, the Engineer will promptly hold a hearing thereon. The Engineer will give to the requesting bidder reasonable notice of the time and place of any such hearing. The bidder may appear at the hearing and present the original working papers, documents, or materials used in the preparation of the bid sought to be withdrawn, together with other facts and arguments in support of his request to withdraw his bid. The bidder shall be required to present a written affidavit that the documents presented are the original, unaltered documents used in the preparation of the bid.

(C) Action by State Highway Administrator

A determination may be made by the Administrator that the bidder meets the criteria for withdrawal of the bid as set forth in Subarticle 103-3(A) upon presentation of

clear and convincing evidence by the bidder. The Engineer will present his findings to the State Highway Administrator for action on the bidder's request. The Engineer will advise the bidder of the Administrator's decision prior to the Board of Transportation's consideration of award.

(D) Bid Bond

If a bid mistake is made and a request to withdraw the bid is made, the bid bond shall continue in full force and effect until there is a determination by the Administrator that the conditions in Subarticle 103-3(A) have been met. The effect of the refusal of the Contractor to give payment and performance bonds within 14 calendar days after the notice of award is received by him, if award has been made by the Board of Transportation after consideration and denial of the Contractor's request to withdraw his bid, shall be governed by the terms and conditions of the bid bond.

103-4 AWARD OF CONTRACT

(A) General

The North Carolina Department of Transportation, in accordance with the provisions of Title VI of the Civil Rights Act of 1964 (78 Statue. 252) and the Regulations of the Department of Transportation (49 CFR, Part 21), issued pursuant to such act, hereby notifies all bidders that it will affirmatively insure that contracts entered in pursuant to advertisements, if awarded, will be made by the Board of Transportation to the lowest responsible bidder without discrimination on the grounds of race, color, or national origin. The lowest responsible bidder will be notified by letter that his bid has been accepted and that he has been awarded the contract. This letter shall constitute the notice of award. The notice of award, if the award be made, will be issued within 60 days after the opening of bids, except that with the consent of the lowest responsible bidder the decision to award the contract to such bidder may be delayed for as long a time as may be agreed upon by the Department and such bidder. In the absence of such agreement, the lowest responsible bidder may withdraw his bid at the expiration of the 60 days without penalty if no notice of award has been issued.

Award of a contract involving any unbalanced bid price(s) may be made in accordance with the requirements of Article 102-15.

(B) Award Limits

A bidder who desires to bid on more than one project on which bids are to be opened on the same date, and who also desires to avoid receiving an award of more projects than he is equipped to handle, may bid on any number of projects but may limit the total amount of work awarded to him on selected projects by completing the form Award Limits on Multiple Projects for each project subject to the award limit. This form will be bound within each proposal. This form will not be effective unless the amount is filled in and the form is properly signed. In the event that a bidder is the lowest responsible bidder on projects subject to the award limit and the value of such projects is more than the award limit established by such bidder, the Board of Transportation will not award such bidder projects from among those subject to the award limit which have a total value exceeding the award limit. The projects to be

awarded to the bidder will be those projects on which award will result in the lowest total cost to the Department of Transportation.

In determining the lowest total cost to the Department, the options of rejecting a bid or readvertising for new bids may be considered.

All bids submitted without the properly executed form Award Limits on Multiple Projects will not be subject to the award limit. In the event that there is a discrepancy between the completed award limit forms submitted by the same bidder for the different projects in a letting, the Department reserves the right to declare all such award limit forms invalid or to make such interpretation of the discrepancy as may be in the best interests of the Department. However, the presence of such discrepancy shall not be reason for declaring any bid irregular nor shall it invalidate the conditions of his bid bond or bid deposit.

Where a prequalified Contractor bids individually (as opposed to a Joint Venture) on one or more projects and also bids on one of more projects as part of a Joint Venture, such individual bidder and such Joint Venture will be considered separate bidders in applying the provisions of this article.

(1) Paper Bids This form will be bound within each proposal. This form will not be effective unless the amount is filled in and the form is properly signed.

(2) Electronic Bids This form is located in the .ebs miscellaneous data file of Expedite. The bidder shall click on yes or no to indicate whether or not the bidder desires to limit the award.

103-5 CANCELLATION OF AWARD

The Board of Transportation reserves the right to rescind the award of any contract at any time before the receipt of the properly executed contract bonds from the successful bidder.

103-6 RETURN OF BID BOND OR BID DEPOSIT

Checks that have been furnished as a bid deposit by all bidders other than the 3 lowest responsible bidders will be retained not more than 10 calendar days after the date of opening of bids. After the expiration of such period, Department of Transportation warrants in the equivalent amount of checks that were furnished as a bid deposit will be issued to all bidders other than the 3 lowest responsible bidders.

Checks that have been furnished as a bid deposit by the 3 lowest responsible bidders will be retained until after the contract bonds have been furnished by the successful bidder, at which time Department of Transportation warrants in the equivalent amount of checks that were furnished as a bid deposit will be issued to the 3 lowest responsible bidders.

Paper bid bonds will be retained by the Department until the contract bonds are furnished by the successful bidder, after which all such bid bonds will be destroyed unless the individual bid bond form contains a note requesting that it be returned to the bidder or the Surety.

103-7 CONTRACT BONDS

The successful bidder, within 14 calendar days after the notice of award is received by him, shall provide the Department with a contract payment bond and a contract performance bond each in an amount equal to 100 percent of the amount of the contract. All bonds shall be in conformance with G.S. 44A-33. The corporate surety furnishing the bonds shall be authorized to do business in the State.

103-8 EXECUTION OF CONTRACT

As soon as possible following receipt of the properly executed contract bonds, the Department will complete the execution of the contract, retain the original contract, and return one certified copy of the contract to the Contractor.

103-9 FAILURE TO FURNISH CONTRACT BONDS

The successful bidder's failure to file acceptable bonds within 14 calendar days after the notice of award is received by him shall be just cause for the forfeiture of the bid bond or bid deposit and rescinding the award of the contract. Award may then be made to the next lowest responsible bidder or the work may be readvertised and constructed under contract or otherwise, as the Board of Transportation may decide.

SECTION 104
SCOPE OF WORK

104-1 INTENT OF CONTRACT

The intent of the contract is to prescribe the work or improvements that the Contractor undertakes to perform, in full compliance with the plans, specifications, special provisions, proposal, and contract. In case the method of construction or character of any part of the work is not covered by the plans, these specifications shall apply. The Contractor shall perform all work in accordance with the lines, grades, typical sections, dimensions, and other data shown on the plans or as may be modified by written orders, and shall do such special, additional, extra, and incidental work as may be considered necessary to complete the work to the full intent of the plans and specifications. Unless otherwise provided in the contract, the Contractor shall furnish all implements, machinery, equipment, tools, materials, supplies, transportation, and labor necessary for the prosecution and completion of the work.

104-2 SUPPLEMENTAL AGREEMENTS

Whenever it is necessary to make amendments to the contract in order to complete satisfactorily the proposed construction and/or to provide authorized time extensions, the Engineer shall have the authority to enter into a supplemental agreement covering such amendments.

Supplemental agreements shall become a part of the contract when executed by the Engineer and an authorized representative of the Contractor. The Contractor shall file with the Engineer a copy of the name or names of his representatives who are authorized to sign supplemental agreements.

104-3 ALTERATIONS OF PLANS OR DETAILS OF CONSTRUCTION

The Engineer reserves the right to make, at any time during the progress of the work, such alterations in the plans or in the details of construction as may be found necessary or desirable. Under no circumstances will an alteration involve work beyond the termini of the proposed construction except as may be necessary to satisfactorily complete the project. Such alterations shall not invalidate the contract nor release the Surety, and the Contractor agrees to perform the work as altered at his contract unit or lump sum prices the same as if it had been a part of the original contract except as otherwise herein provided.

An adjustment in the affected contract unit or lump sum prices due to alterations in the plans or details of construction that materially change the character of the work and the cost of performing the work will be made by the Engineer only as provided in this article.

If the Engineer makes an alteration in the plans or details of construction, which he determines will materially change the character of the work and the cost of performing the work, an adjustment will be made and the contract modified in writing accordingly. The Contractor will be paid for performing the affected work in accordance with Subarticle 104-8(A).

When the Contractor is required to perform work which is, in his opinion, an alteration in the plans or details of construction which materially changes the character of the work and the cost of performing the work, he shall notify the Engineer in writing prior to performing such work. The Engineer will investigate and, based upon his determination, one of the following will occur:

(A) If the Engineer determines that the affected work is an alteration of the plans or details of construction that materially changes the character of the work and the cost of performing the work, the Contractor will be notified in writing by the Engineer and compensation will be made in accordance with Subarticle 104-8(A).

(B) If the Engineer determines that the work is not such an alteration in the plans or details of construction that materially changes the character of the work and the cost of performing the work, he will notify the Contractor in writing of his determination. If the Contractor, upon receipt of the Engineer's written determination, still intends to file a claim for additional compensation by reason of such alteration, he shall notify the Engineer in writing of such intent prior to beginning any of the alleged altered work and the provisions of Subarticle 104-8(B) shall be strictly adhered to.

No contract adjustment will be allowed under this article for any effects caused on unaltered work.

104-4 SUSPENSIONS OF WORK ORDERED BY THE ENGINEER

(A) Suspensions of the Work Ordered by the Engineer

When the Engineer suspends in writing the performance of all or any portion of the work for a period of time not originally anticipated, customary, or inherent to the construction industry and the Contractor believes that additional compensation for idle equipment and/or labor is justifiably due as a result of such suspension, the Contractor shall notify the Engineer in writing of his intent to file a claim for additional compensation within 7 days after the Engineer suspends the performances of the work and the provisions of Subarticle 104-8 (C) shall be strictly adhered to.

Within 14 calendar days of receipt by the Contractor of the notice to resume work, the Contractor shall submit his claim to the Engineer in writing. Such claim shall set forth the reasons and support for such adjustment in compensation, including cost records, and any other supporting justification in accordance with Subarticle 104-8(C).

(B) Alleged Suspension

If the Contractor contends he has been prevented from performing all or any portion of the work for a period of time not originally anticipated, customary, or inherent to the construction industry because of conditions beyond the control of and not the fault of the Contractor, its suppliers, or subcontractors at any tier, and not caused by weather, but the Engineer has not suspended the work in writing, the Contractor shall submit in writing to the Engineer a notice of intent to file a claim for additional compensation by reason of such alleged suspension. No adjustment in compensation will be allowed for idle equipment and/or labor prior to the time of the submission of the written notice of intent to file a claim for additional compensation by reason of such alleged suspension. Upon receipt, the Engineer will evaluate the Contractor's notice of intent to file a claim for additional compensation. If the Engineer agrees with the Contractor's contention, the Engineer will suspend in writing the performance of all or any portion of the work and the requirements of Subarticle 104-8(C) shall be strictly adhered to.

If the Engineer does not agree with the Contractor's contention as described above and determines that no portion of the work should be suspended, he will notify the Contractor in writing of his determination. If the Contractor does not agree with the Engineer's determination, the requirements of Subarticle 104-8(C) shall be strictly adhered to. Within 14 calendar days after the last day of the alleged-suspension, the Contractor shall submit his claim to the Engineer in writing. Such claim shall set forth the reasons and support for such adjustment in compensation, including cost records, and any other supporting justification in accordance with Subarticle 104-8(C).

(C) Conditions

No adjustment in compensation will be allowed under Subarticles 104-4(A) and 104-4(B) for any reason whatsoever for each occurrence of idle equipment and/or idle labor which has a duration of twenty-four hours or less.

No adjustment in compensation will be allowed under Subarticles 104-4(A) and 104-4(B) to the extent that performance would have been suspended by any other cause, or for which an adjustment is provided for or excluded under any other term or condition of this contract.

No adjustment in compensation will be allowed under Subarticles 104-4(A) and 104-4(B) for any effects caused on unchanged work. No adjustment in compensation will be allowed under Subarticles 104-4(A) and 104-4(B) except for idle equipment and/or idle labor resulting solely from the suspension of work in writing by the Engineer.

No adjustment in compensation will be allowed under Subarticles 104-4(A) and 104-4(B) where temporary suspensions of the work have been ordered by the Engineer in accordance with Article 108-7 and the temporary suspensions are a result of the fault or negligence of the Contractor.

104-5 OVERRUNS AND UNDERRUNS OF CONTRACT QUANTITIES

(A) General

The Engineer reserves the right to make at any time during the work such changes in quantities as are necessary to satisfactorily complete the project. Such changes in quantities shall not invalidate the contract nor release the surety, and the Contractor agrees to perform the work as changed. The Engineer will notify the Contractor in writing of the significant changes in the quantities.

The Contractor will be entitled to an adjustment in contract unit prices for increased costs incurred over the original bid prices in performing contract items that overrun or underrun the estimated contract quantities only as provided for in this article.

(B) Overruns--Increase in Unit Price

If the actual quantity of any major contract item overruns the original bid quantity by more than 15 percent of such original bid quantity, or the actual quantity of any minor contract item overruns the original bid quantity by more than 100 percent of such original bid quantity, an increase in the contract unit price, excluding loss of anticipated profits, may be authorized by the Engineer. Revised contract unit prices pertaining to overruns will be applicable only to that portion of the overrun that is in excess of the percentages stated above.

(1) Whenever it is anticipated that an overrun in a major or minor contract item in excess of that described above will occur, the Contractor may make written request for a revision in contract unit prices. It shall be incumbent upon the Contractor to justify the request for a revision in contract unit prices. After reviewing the Contractor's request, the Engineer will notify the Contractor of his determination as follows:

(a) If the Engineer determines a revision in the contract unit price is justified, and the Engineer and the Contractor are in agreement as to the revision to be made in the contract unit price, a supplemental agreement covering the revised unit price will be consummated prior to performing work on that quantity in excess of the percentage set forth above.

If the Engineer determines a revision in the contract unit price is justified, and the Engineer and the Contractor are not in agreement as to the revision to be made in the contract unit price, the Engineer will issue a force account notice prior to performing work on that quantity in excess of the percentage set forth above.

(b) If the Engineer determines a revision in the contract unit price is not justified he will notify the Contractor of his determination in writing and payments will be made for the work at the contract unit price. Upon completion of the work, the Contractor may request an adjustment in the contract unit price as provided in paragraph 2 below.

(2) Whenever an overrun in a contract item in excess of the percentages previously set forth has occurred and a supplemental agreement establishing an increase in the contract unit price has not been executed or the Engineer has not issued a force account notice, the Contractor may make written request for a revision in the original contract unit price. Any adjustment in the contract unit prices due to overruns will be made by the Engineer based upon his evaluation and comparison of the Contractor's documented cost records the contract unit prices for those contract items. The Contractor's documented cost records for the work performed on those quantities beyond the percentages stated above shall be kept in accordance with the requirements of Article 109-3. The Contractor's cost records and supporting data shall be complete in every respect and in such form that they can be checked. It shall be incumbent upon the Contractor to satisfy the Engineer of the validity of any request presented by the Contractor for an adjustment in contract unit price. After reviewing the Contractor's request, the Engineer can make such adjustment as he deems warranted based upon his engineering judgment and the payment to the Contractor will be made accordingly.

(C) Underruns--Increase in Unit Price

If the actual quantity of any major contract item underruns the original bid quantity by more than 15 percent of such original bid quantity, an increase in the contract unit price, excluding loss of anticipated profit, may be authorized by the Engineer. Revised contract unit prices pertaining to underruns of major contract items will be applicable to the entire quantity of the contract item that underruns. No revision will be made to the contract unit price for any minor contract item that underruns the original bid quantities.

Whenever it is anticipated that an underrun in a major contract item in excess of that described above will occur, the Contractor may make written request for a revision in contract unit price. If the Engineer and the Contractor are in agreement as to the revision to be made in the contract unit price, then a supplemental agreement covering the revised unit price will be entered into. If the Engineer and the Contractor are not in agreement, then after performance of the work, a revised unit price may be determined as described below.

Whenever an underrun in a major contract item in excess of the percentage previously set forth has occurred, and a supplemental agreement establishing an increase in the contract unit price has not been executed, the Contractor may make written request for a revision in the original contract unit price. The Contractor shall submit sufficient documentation and analysis of his costs to satisfy the Engineer of any non-recovered costs included in the item that underran. Any adjustment in contract unit prices due to underruns will be made by the Engineer based upon his evaluation of the Contractor’s documentation and analysis showing how changes in contract item cost are attributable to the underrun. An analysis of costs shall be supplemented with the Contractor’s documented cost records for work performed on the total quantity of the affected item where the Contractor’s request for compensation includes compensation for costs other than recovered fixed costs. The Contractor’s cost records shall be complete in every respect and in such form that

Engineer can check them. It shall be incumbent upon the Contractor to satisfy the Engineer of the validity of any request presented by the Contractor for adjustment in contract unit price. After reviewing the Contractor's request, the Engineer may make such adjustment as he deems warranted based upon his engineering judgement and the payment will be made on the final estimate. The total payment including any additional compensation granted by the Engineer due to an underrun in a major contract item shall not exceed the payment that would have been made for the performance of 100 percent of the original contract quantity at the original contract unit price.

In the event of underruns of major items less than 15 percent and underruns of minor items, that involve fabricated materials and that are not considered to be stock items, if fabrication of such material is begun or completed before the Contractor is advised of the reduction in the quantity of the pay item, the Department will reimburse the Contractor for the verified fabrication cost, including the cost of material less salvage value, or it may instruct the Contractor to have the fabricated material delivered to a site designated by the Engineer and make payment for such material in accordance with Article 109-6.

(D) Overruns and Underruns--Reduction in Unit Price

Whenever it is anticipated that an overrun or underrun in a major contract item in excess of 15 percent or an overrun in a minor contract item in excess of 100 percent will occur, the Engineer may make written request for a reduction in contract unit price. If the Engineer and the Contractor are in agreement as to the decrease to be made in the contract unit price, a supplemental agreement covering the revised unit price will be consummated prior to beginning work on that quantity in excess of the allowable percentages. If the Engineer and the Contractor are not in agreement as to the decrease to be made, the Contractor will be directed to perform the affected work on a force account basis. Payment for the affected work will be made based upon force account records kept in accordance with Article 109-3 but shall not exceed that payment that would have been made at the contract unit price.

104-6 ELIMINATED CONTRACT ITEMS

The Engineer may eliminate any item from the contract, and such action will in no way invalidate the contract. In the event the item of work involves pre-fabricated materials, which are not considered to be stock items, and fabrication of such material is begun or completed before the Contractor is advised of the elimination of the contract item, the Department may reimburse the Contractor for the verified fabrication cost including the cost of materials less salvage value or may instruct the Contractor to have the fabricated material delivered to a site designated by the Engineer and make payment for such material in accordance with Article 109-6.

If the Contractor has partially completed a contract item prior to notification of the elimination of such item, the Department will reimburse the Contractor for the verified actual cost of the partially completed work not to exceed the payment that would have been made at the contract unit or lump sum price for the completed work.

In any event no payment will be made for loss of anticipated profits and no other allowance will be made for eliminated items except as listed above.

104-7 EXTRA WORK

The Contractor shall perform extra work whenever it is deemed necessary or desirable to complete fully the work as contemplated. Extra work shall be performed in accordance with the contract and as directed. No extra work shall be commenced prior to specific authorization for the performance of such extra work being given by the Engineer.

Extra work that is specifically authorized by the Engineer will be paid for in accordance with Subarticle 104-8(A).

When the Contractor is required to perform work which is in his opinion extra work, he shall notify the Engineer in writing prior to performing such work. The Engineer will investigate and, based upon his determination, one of the following will occur.

(A) If the Engineer determines that the affected work is extra work, the Contractor will be notified in writing by the Engineer and compensation will be made in accordance with Subarticle 104-8(A).

(B) If the Engineer determines that the work is not extra work, he will notify the Contractor in writing of his determination. If the Contractor upon receipt of the Engineer's written determination intends to file a claim for additional compensation by reason of such work, he shall notify the Engineer in writing of such intent prior to beginning any of the alleged extra work and in conformance with the requirements of Subarticle 104-8(B).

104-8 COMPENSATION AND RECORD KEEPING

(A) Compensation

When the Engineer and Contractor agree that compensation is due under the requirements of Articles 104-3 or 104-7, payment will be made in accordance with one of the following:

(1) When the Engineer and the Contractor agree to the prices to be paid, the agreement will be set forth in a supplemental agreement. If the estimated total cost of the affected work is equal to or less than $25,000.00 and the prices for performing the work have been mutually agreed to, the Contractor may begin work before executing the supplemental agreement. If the estimated total cost of the affected work is more than $25,000.00, the Contractor shall not begin the affected work until the supplemental agreement is executed.

(2) When the Engineer and the Contractor cannot agree to the prices to be paid for the affected work, the Engineer will issue a force account notice prior to the Contractor beginning work. In this instance the affected work shall be performed as directed by the Engineer and paid for in accordance with the requirements of Article 109-3.

(B) Claim for Additional Compensation

The Contractor's notice of intent to file a claim for additional compensation under the requirements of Articles 104-3 and 104-7 shall be given to the Engineer in writing. The Contractor shall keep accurate and detailed cost records in accordance with the requirements of Article 109-3. The Contractor's cost records and supporting data shall be complete in every respect and in such form that they may be checked by the Engineer. The Contractor's cost records and supporting data shall clearly indicate the

cost of performing the work in dispute and shall separate the cost of any work for which payment has been made. The Contractor's cost records shall be kept up to date and the Engineer shall be given the opportunity to review the methods by which the records are being maintained. The cost records shall be prepared on a weekly basis for each occurrence for which notice of intent to file a claim has been given and submitted to the Engineer within 7 days after the end of a given weekly period.

If the Contractor chooses to pursue the claim after the disputed work is complete, he shall submit a written claim to the Engineer for an adjustment in compensation based upon his cost records within 120 calendar days after completion of the disputed work. This claim shall summarize previously submitted cost records and clearly describe the Contractor's justification for an adjustment in compensation under the terms of the contract. The claim shall be accompanied by a certification from an officer of the company or person authorized to execute supplemental agreements, stating that the claim is truthful and accurate.

Upon receipt, the Engineer will review the Contractor's request and supporting documentation and notify the Contractor if the request is complete with all necessary supporting documentation and cost records.

If the Engineer determines that the work covered by the claim is in fact compensable under the terms of the contract, an adjustment in compensation will be made based upon the documentation presented and his engineering judgment. The adjustment will be made on the next partial pay estimate and reflected on the final estimate. The compensation allowed shall be limited to the amount that would be paid if the work was performed in accordance with Article 109-3.

If the Engineer determines that the work covered by the claim is not compensable under the terms of the contract, the claim will be denied.

The Engineer will notify the Contractor of his determination whether or not an adjustment of the contract is warranted within 120 calendar days after receipt of the complete request, all necessary supporting justification, and cost records.

The failure on the part of the Contractor to perform any of the following shall be a bar to recovery under the requirements of Articles 104-3 or 104-7:

(1) The failure to notify the Engineer in writing prior to performing the work in dispute that he intends to file a claim.

(2) The failure of the Contractor to keep records in accordance with the requirements of Article 109-3.

(3) The failure of the Contractor to give the Engineer the opportunity to monitor the methods by which records are being maintained.

(4) The failure of the Contractor to submit additional documentation requested by the Engineer provided documentation requested is available within the Contractor's records.

(5) The failure of the Contractor to submit cost records on a weekly basis.

(6) The failure of the Contractor to submit the written request for an adjustment in compensation with cost records and supporting information within 120 calendar days of completion of the affected work.

(C) Compensation

The Contractor's notice of intent to file a claim for additional compensation under the requirements of Subarticle 104-4(A) shall be given to the Engineer in writing within 7 days after the Engineer suspends the performance of the work. For an alleged suspension, the Contractor's notice of intent to file a claim for additional compensation under the requirements of Subarticle 104-4(B) shall be given to the Engineer in writing. The Contractor shall keep accurate and detailed records of the alleged idle equipment and alleged idle labor. The Contractor's cost records, supporting data, and supporting information shall be complete in every respect and in such form that they may be checked by the Engineer. The Contractor's cost records, supporting data, and supporting information for equipment idled due to the suspension or alleged suspension shall specifically identify each individual piece of equipment, its involvement in the work, its location on the project, the requested rental rate and justification as to why the equipment cannot be absorbed into unaffected work on the project during the period of suspension or alleged suspension. The Contractor's cost records, supporting data, and supporting information for idle labor shall include the specific employees, classification, dates and hours idled, hourly rate of pay, their involvement in the project, and justification as to why they cannot be absorbed into the unaffected work on the project or other projects during the period of suspension or alleged suspension. The Contractor's cost records, supporting data, and supporting information shall be kept up-to-date and the Engineer shall be given the opportunity to review the methods by which the records, data, and information are being maintained. The cost records, supporting data, and supporting information shall be prepared on a weekly basis for each occurrence for which notice of intent to file a claim has been given and submitted to the Engineer within 7 days after the end of a given weekly period.

If the Contractor chooses to pursue the claim after the suspension or alleged suspension period has ended, he shall submit a written claim to the Engineer for an adjustment in compensation based upon his cost records due to idle equipment and/or idle labor within 14 calendar days of receipt of the notice to resume work or within 14 calendar days of expiration of the alleged suspension period. This request shall summarize previously submitted cost records and clearly describe the Contractor's justification for an adjustment in compensation under the terms of the contract.

Upon receipt, the Engineer will evaluate the Contractor's request. If the Engineer agrees that the cost of the work directly associated with the suspension or alleged suspension has increased as a result of such suspension or alleged suspension and the suspension or alleged suspension was caused by conditions beyond the control of and not the fault of the Contractor, its suppliers, or subcontractors at any approved tier, and not caused by weather, the Engineer will make an adjustment, excluding profit, and modify the contract in writing accordingly. The Contractor will be paid for the verified actual cost of the idle equipment and idle labor. The compensation allowed shall be limited to the equipment, labor, bond, insurance, and tax costs, excluding profits, computed in accordance with Article 109-3.

If the Engineer determines that the suspensions of the work by the Engineer or alleged suspensions do not warrant an adjustment in compensation, he will notify the Contractor in writing of his determination.

The Engineer will notify the Contractor of his determination of whether or not an adjustment in compensation is warranted within 120 calendar days after receipt of the complete request, all necessary supporting justification, and cost records.

The failure on the part of the Contractor to perform any of the following shall be a bar to recovery under the requirements of Article 104-4:

(1) The failure to notify the Engineer in writing within 7 days after the Engineer suspends in writing the performance of all or any portion of the work.

(2) The failure to notify the Engineer in writing that he intends to file a claim by reason of alleged suspension.

(3) The failure of the Contractor to keep records in accordance with the details of Article 109-3.

(4) The failure of the Contractor to give the Engineer the opportunity to monitor the methods by which records are being maintained.

(5) The failure of the Contractor to submit additional documentation requested by the Engineer provided documentation requested is available within the Contractor's records.

(6) The failure of the Contractor to submit cost records on a weekly basis.

(7) The failure of the Contractor to submit the written request for an adjustment in compensation with cost records, supporting data, and supporting information within 14 calendar days of receipt of the notice to resume work.

(8) The failure of the Contractor to submit the written request for an adjustment in compensation with cost records, supporting data, and supporting information within 14 calendar days after the last day of the period during which the Contractor contends he has been prevented from performing all or any portion of the work for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) because of conditions beyond the control of and not the fault of the Contractor, its suppliers, or subcontractors at any approved tier, and not caused by weather.

(D) Notification of Determination

The failure on the part of the Engineer to notify the Contractor of his determination on the requested adjustment in compensation within 120 calendar days after receipt of the complete request, all supporting justification, and cost records will result in payment of interest on any monies determined to be due from the requested adjustment in compensation. Interest, at the average rate earned by the State Treasurer on the investment within the State's Short Term Investment Fund during the month preceding the date interest becomes payable, will be paid the Contractor on the next partial pay estimate and reflected on the final estimate for the period beginning on the 121st day after receipt of the complete request, all supporting justification, and cost records, and extending to the date the Engineer makes his determination on the disputed work.

If the Contractor fails to receive such adjustment in compensation for the disputed work as he claims to be entitled to under the terms of the contract, the Contractor may resubmit the written request for an adjustment in compensation to the Engineer as a part of the final claim after the project is complete. The Contractor will only be allowed to submit the request for an adjustment in compensation one time during the construction of the project.

104-9 DISPOSITION OF SURPLUS PROPERTY

All property that is surplus to the needs of the project will remain or become the property of the Contractor, unless otherwise stated in the contract, with the following exceptions:

(A) Materials that are the property of utility companies providing service to buildings that are to be demolished or removed in accordance with Sections 210 and 215.

(B) Materials resulting from the removal of existing pavement in accordance with Section 250 that are to be stockpiled for the use of the Department.

(C) Materials resulting from the removal of existing structures in accordance with Section 402 where the contract indicates that the material will remain the property of the Department.

(D) Aggregate base course where the contract requires that this material become the property of the Department.

(E) Left over materials for which the Department has reimbursed the Contractor as provided in Article 109-6 and

(F) Materials that have been furnished by the Department for use on the project.

Property shall include but not be limited to materials furnished by the Contractor or the Department for either temporary or permanent use on the project, salvaged materials which were part of the existing facility on the date of availability for the project, and all implements, machinery, equipment, tools, supplies, laboratories, field offices, and watercraft which are necessary for the satisfactory completion of the project.

All property that is the property of the Contractor shall be removed from the project by the Contractor prior to final acceptance.

104-10 MAINTENANCE OF THE PROJECT

The Contractor shall maintain the project from the date of availability or the date of beginning work, whichever occurs first, until the project is finally accepted. On resurfacing projects the Contractor shall maintain each part of the project, as defined by map numbers, from the date of beginning work on that part until such part is finally accepted. This maintenance shall be continuous and effective and shall be prosecuted with adequate equipment and forces to the end that all work covered by the contract is kept in satisfactory and acceptable condition at all times.

The Contractor shall maintain all existing drainage facilities, except where the work consists of resurfacing only, such that they are in the same condition upon acceptance of the project as they were when the project was made available to the Contractor.

In the event that the Contractor's work is suspended for any reason, the Contractor shall maintain the work covered by the contract, as provided herein.

When a portion of the project is accepted as provided in Article 105-17, immediately after such acceptance the Contractor will not be required to maintain the accepted portions. Should latent defects be discovered or become evident in an accepted portion of the project, such defective work shall be repaired or replaced at no cost to the Department.

Where an observation period(s) is required that extends beyond the final acceptance date, the Contractor shall perform any work required by the observation period until satisfactory completion of the observation period. The Contractor will not be directly compensated for any maintenance operations necessary, as this work will be considered incidental to the work covered by the various contract items.

104-11 FINAL CLEANING UP

Before acceptance of the project, the highway, borrow sources, waste areas, and all ground occupied by the Contractor within the project limits in connection with the work shall be cleaned of all rubbish, excess materials, temporary structures, and equipment; and all parts of the work shall be left in an acceptable condition.

The Contractor will not be directly compensated for the work of final cleaning up, as this work will be considered incidental to the work covered by the various contract items.

104-12 VALUE ENGINEERING PROPOSAL

This value engineering specification is to provide an incentive to the Contractor to initiate, develop, and present to the Department of Transportation for consideration, any cost reduction proposals conceived by him involving changes in the contract. This specification does not apply unless the proposal submitted is specifically identified by the Contractor as being presented for consideration as a Value Engineering Proposal. Submittals that propose material substitutions of permanent features such as changes from rigid to flexible or flexible to rigid pavements, concrete to steel or steel to concrete bridges will not be considered acceptable Value Engineering Proposals. Depending on complexity of evaluation and implementations, Value Engineering Proposals that provide for a total savings prior to distribution of less than ten thousand dollars ($10,000) will not be generally considered.

Value Engineering Proposals contemplated are those that would result in a net savings to the Department by providing a decrease in the total cost of construction or reduce the construction time without increasing the cost to construct the project. The effects the Proposal may have on the following items, but not limited to these items, will be considered by the Department when evaluating the proposal:

(A) Service life
(B) Safety
(C) Reliability
(D) Economy of operation
(E) Ease of maintenance
(F) Desired aesthetics
(G) Design
(H) Standardized features
(I) Environmental impact

The Department reserves the right to reject the proposal or deduct from the savings identified in the Proposal to compensate for any adverse effects to these items which may result from implementation of the Proposal.

The Department reserves the right to reject at its discretion any Value Engineering Proposal submitted which would require additional right of way. Substitution of another design alternate, which is detailed in the contract plans, for the one on which the Contractor bid, will not be allowed. Plan errors which are identified by the Contractor and which result in a cost reduction will not qualify for submittal as a Value Engineering Proposal. Pending execution of a formal supplemental agreement, implementing an approved Value Engineering Proposal, the Contractor shall remain obligated to perform in accordance with the terms of the existing contract. No time extension will be granted due to the time required to review a Value Engineering Proposal.

The Contractor is encouraged to include this specification in contracts with subcontractors. The Contractor shall encourage submissions of Value Engineering Proposals from subcontractors, however, it is not mandatory that the Contractor accepts or transmits to the Department, Value Engineering Proposals proposed by his subcontractors. The Contractor may choose any arrangement for the subcontractor value engineering payments, provided that these payments shall not reduce the Department's share of the savings resulting from the Value Engineering Proposal.

Should the Contractor desire a preliminary review of a possible Value Engineering Proposal, prior to expending considerable time and expense in full development, a copy of the preliminary proposal shall be submitted to the Resident Engineer and the Value Engineering Office. The submittal shall state Preliminary Value Engineering Proposal Review Request and shall contain sufficient drawings, cost estimates and written information that can be clearly understood and interpreted. Also, include the identity of any Private Engineering Firms proposed by the Contractor to prepare designs or revisions to designs. The Department will review the preliminary submittal only to the extent necessary to determine if it has possible merit as a Value Engineering Proposal. This review does not obligate the Department to approve the final proposal should a preliminary review indicate the proposal has possible merit. The Department is under no obligation to consider any Value Engineering Proposal (Preliminary or Final) that is submitted.

A copy of the Final Value Engineering Proposal shall be submitted by the Contractor to the Resident Engineer and the Value Engineering Office. The proposal shall contain, as a minimum, the following:

(A) A statement that the request for the modification is being made as a Value Engineering Proposal.

(B) A description of the difference between the existing contract requirements and the proposed modifications, with the comparative advantages and disadvantages of each.

(C) If applicable, a complete drawing of the details covering the proposed modifications and supporting design computations shall be included in the final submittal. The preparation of new designs or drawings shall be accomplished and sealed by a Professional Engineer licensed in the State of North Carolina. Further, the Department may require a review, and possibly the redesign, be accomplished by the project's original designer, or an approved equal. The Department may contract with

private engineering firms, when needed, for reviews requested by the Department. The contractor shall contract with the original project designer, or an approved equal, when required by the Department, for any design work needed to completely and accurately prepare contract drawings. The Department may waive the requirements to have the preparation of contract drawings accomplished by a Professional Engineer or the project's original design based on the extent, detail, and complexity of the design needed to implement the value engineering proposal.

(D) An itemized list of the contract requirements that would be modified and a recommendation of how to make each modification.

(E) A detailed estimate of the cost of performing the work under the proposed modification.

(F) A statement of the time by which approval of the Value Engineering Proposal shall be issued by the Department to obtain the total estimate cost reduction during the remainder of the contract, noting any effect on the contract completion or delivery schedule.

To facilitate the preparation of revisions to contract drawings, the contractor may purchase reproducible copies of drawings for his use through the Department's Value Engineering Office. The preparation of new design drawings by or for the Contractor shall be coordinated with appropriate Department Branch through the Value Engineering Office. The Contractor shall provide, at no charge to the Department, one set of reproducible drawings of the approved design needed to implement the value engineering proposal.

The Engineer will be the sole judge of the acceptability of a Value Engineering Proposal requested in accordance with these requirements and of the estimated net savings resulting from the approval of all or any part of the Proposal. The Contractor has the right to withdraw, in whole or in part, any Value Engineering Proposal not accepted by the Department within the period to be specified in the proposal per Item (F) of the preceding paragraph.

If a Value Engineering Proposal is approved, the necessary changes will be effected by Supplemental Agreement. Included as a part of the Supplemental Agreement will be requirements for price adjustment giving the Contractor 50 percent of the net savings to the project resulting from the modifications.

The Department reserves the right to include in the Supplemental Agreement any conditions it deems appropriate for consideration, approval, and implementation of the proposal. Acceptance of the Supplemental Agreement by the Contractor shall constitute acceptance of such conditions.

The final net savings to be distributed will be the difference in cost between the existing contract cost for the involved unit bid items and actual final cost occurring as a result of the modification. Only those unit bid items directly affected by the Supplemental Agreement will be considered in making the final determination of net savings. In determining the estimate net savings, the Department reserves the right to disregard the contract prices if, in the judgement of the Department, such prices do not represent a fair measure of the value of the work to be performed or to be deleted. Subsequent change documents affecting the modified unit bid items but not related to the Value Engineering Proposal will be excluded from such determination. The Department's review and administrative costs for value

engineering proposals will be borne by the Department. The Contractor's costs for designs and/or revisions to designs and the preparation of design drawings will be borne by the Contractor. The costs to either party will not be considered in determining the net savings obtained by implementing the value engineering proposal. The Contractor's portion of the net savings shall constitute full compensation to him for effecting all changes pursuant to the agreement. The net savings will be prorated, 50 percent for the Contractor and 50 percent for the Department, for all accepted Value Engineering Proposals.

Upon execution of the Supplemental Agreement, the Department will thereafter have the right to use, duplicate or disclose in whole or in part any data necessary for utilization of the modification on other projects without obligation or compensation of any kind to the Contractor. Restrictions or conditions imposed by the Contractor for use of the proposal on other projects shall not be valid.

Except as may be otherwise precluded by this specification, the Contractor may submit a previously approved value engineering proposal on another project.

Unless and until a Supplemental Agreement is executed and issued by the Department, the Contractor shall remain obligated to perform the work in accordance with the terms of the existing contract.

Acceptance of the modification and its implementation will not modify the completion date of the contract unless specifically provided for in the Supplemental Agreement.

The Contractor shall not be entitled to additional compensation under Section 104 for alterations in the plans or in the details of construction pursuant to the Value Engineering Proposal.

The Department will not be liable to the Contractor for failure to accept or act upon any Value Engineering Proposal nor for any delays to the work attributable to any such proposal.

The Department reserves the right to negotiate desired changes with the Contractor under the requirements of the contract even though the changes are the result of a Value Engineering Proposal submitted on another contract. In this instance the savings will be prorated in accordance with the terms of the negotiated agreement.

104-13 RECYCLED PRODUCTS OR SOLID WASTE MATERIALS

It is the policy of the Department of Transportation to aid in reduction of materials that become a part of our solid waste stream. To that extent the Department encourages contractors to initiate, develop, and utilize products and/or construction methods that incorporate the use of recycled or solid waste products in this project. Recycled products or waste materials will be those products or materials which would otherwise become solid waste and are collected, separated, or processed and reused or returned to reuse in the form of raw materials or products that are incorporated into a beneficial reuse on the project. Targeted materials include but are not limited to the following: plastic, glass, paper, cardboard, shingles, tires, fly ash, bottom ash, sludge and construction and demolition debris.

This Specification will not be applicable to reclaimed asphalt materials used in accordance with the Section 610 and shall not be applicable to any recycled or solid waste materials that are specified for use by the Department on this project.

To use recycled or solid waste materials, the Contractor shall submit to the Department of Transportation a Recycled Products or Solid Waste Materials Proposal for approval. This proposal shall be submitted to the Resident Engineer and the Project Services Unit. The proposal shall contain, as a minimum, the following.

(A) A statement that the request for the modification is being made as a Recycled Products or Solid Waste Materials proposal.

(B) A description of the difference between the existing contract requirements and the proposed modification and the comparative advantages and disadvantages of each.

(C) If applicable, a complete drawing of the details covering the proposed modifications and supporting computations shall be included in the submittal. The preparation of new designs or revisions to the design shown in the contract drawings shall be accomplished by a professional engineer licensed in North Carolina. The Department may waive this requirement based on the extent, detail, and complexity of the design needed to implement the proposal.

(D) An itemized list of the contract requirements that would be modified and a recommendation of how to make each modification.

(E) A detailed estimate of the cost of performing the work under the proposed modification.

(F) A statement of the time by which approval of the proposal shall be issued by the Department to maintain the completion date of the contract.

The Contractor shall be responsible for obtaining any and all permits that may be required for the hauling, storing, or handling of the targeted materials.

If a Recycled Products or Solid Waste Materials proposal is approved, the necessary changes will be effected by Supplemental Agreement. Included as a part of the Supplemental Agreement will be requirements for price adjustment as follows:

(A) If the proposal results in a net savings to the Department the savings and distribution of the savings shall be done in accordance with the requirements of Article 104-12.

(B) If the proposal results in a net increase in the project cost but is judged to have a significant effect on the development of long term markets for the targeted materials; or results in significant beneficial usage of project generated debris that would have otherwise been disposed of in accordance with Section 802, the Department will bear the approved increased costs, if any. This includes recycled products that have been approved by the Department but were not originally included in this contract.

(C) If the proposal is new and innovative, never utilized in the Department projects before as approved by the Engineer and results in a net savings to the Department, the savings shall be distributed in accordance with Article 104-12. However, when this innovative proposal results in a net increase in project cost, part B of this Specification shall apply, and a minimum of $500 (but not more than $2,500) may be awarded to the Contractor.

The Contractor shall provide certification that verifies the source of the material, and the percentage of targeted materials to be utilized.

The Contractor shall remain obligated to perform the work in accordance with the terms of the existing contract pending execution of the Supplemental Agreement

which implements an approved Recycled Products or Solid Waste Materials proposal and will not be entitled to any additional compensation or additional contract time if a Recycled Products or Solid Waste Materials proposal is not accepted.

The Department reserves the right to reject, at its discretion, any Recycled Products or Solid Waste Materials proposal. The Engineer will be the sole judge of the acceptability, the value, the estimated net savings, and any additional compensation to be paid to the Contractor for all or any part of the proposal.

The requirements of Article 104-3 do not apply to a Recycled Products or Solid Waste Materials proposal.

Upon execution of the Supplemental Agreement, the Department will hereafter have the right to use, duplicate or disclose in whole or in part any data necessary for utilization of the modification on other projects without obligation or compensation of any kind to the Contractor. Restrictions of conditions imposed by the Contractor for use of the proposal by the Department on other projects shall not be valid.

The Department will not be liable to the Contractor for failure to accept or act upon any Recycled Products or Waste Materials proposal submitted pursuant to this Specification nor for any delays to the work attributable to any third party claims, or fines that may be levied as a result of the Contractor's decision to use targeted materials.

SECTION 105
CONTROL OF WORK

105-1 AUTHORITY OF THE ENGINEER

The Engineer will decide all questions which may arise as to the quality and acceptability of materials furnished and work performed and as to the rate of progress of the work; all questions which may arise as to the interpretation of the contract; and all questions as to the acceptable fulfillment of the contract on the part of the Contractor. His decision shall be final and he shall have executive authority to enforce and make effective such decisions and orders as the Contractor fails to carry out promptly.

The Engineer shall have the authority to issue any written order to the Contractor which he considers necessary to the prosecution of the work, and shall have executive authority to enforce such written orders as the Contractor fails to carry out promptly. Failure on the part of the Contractor to comply with any written order issued by the Engineer may be justification for disqualifying the Contractor from further bidding in accordance with Article 102-16.

105-2 PLANS AND WORKING DRAWINGS

Plans will show details of all structures, lines, grades, typical cross sections of the roadway, location and design of all structures, and a summary of items appearing in the proposal.

The plans shall be supplemented by such approved working drawings as are necessary to adequately control the work. Working drawings furnished by the Contractor and approved by the Engineer shall consist of such detailed drawings as may be required to adequately control the work and are not included in the plans furnished by the Department. They may include stress sheets, shop drawings, erection drawings, falsework drawings, cofferdam drawings, bending diagrams for reinforcing steel, catalog cuts, or any other supplementary drawings or similar data required of the Contractor. When working drawings are approved by the Engineer, such approval shall not operate to relieve the Contractor of any of his responsibility under the contract for the successful completion of the work.

Unless otherwise specified, the Contractor shall allow 40 calendar days for review and approval, or acceptance, of working drawings from the date they are received until they are returned by the Engineer. If revised drawings are required, appropriate additional time shall be allowed for review and approval, or acceptance, of the revised drawings. The Contractor shall have no claim for extension of the completion date(s) or additional compensation due to this review period.

Changes on shop drawings after approval and/or distribution shall be subject to the approval of the Engineer and he shall be furnished a record of such changes.

Payment at the several contract prices will be full compensation for all costs of furnishing all working drawings.

105-3 CONFORMITY WITH PLANS AND SPECIFICATIONS

All work performed and all materials furnished shall be in reasonably close conformity with the lines, grades, cross sections, dimensions, and material requirements, including tolerances, shown in the contract.

In the event the Engineer finds the materials or the finished product in which the materials are used not within reasonably close conformity with the contract but that reasonably acceptable work has been produced, he will then make a determination if the work is to be accepted and remain in place. If the Engineer determines that the work is to be accepted, he will have the authority to make such adjustment in contract price as he deems warranted based upon his engineering judgment and the final estimate will be paid accordingly.

In the event the Engineer finds the materials or the finished product in which the materials are used or the work performed are not in reasonably close conformity with the contract and have resulted in an inferior or unsatisfactory product, the work or materials shall be removed and replaced or otherwise corrected by the contractor at no cost to the Department.

105-4 COORDINATION OF PLANS, SPECIFICATIONS, SUPPLEMENTAL SPECIFICATIONS, AND SPECIAL PROVISIONS

The specifications, the supplemental specifications, the plans, the special provisions, and all supplementary documents are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. They are complimentary and provide and describe the complete contract. In case of discrepancy, the following will apply in ascending order:

Calculated dimensions shall govern over scaled dimensions

Supplemental Specifications shall govern over Standard Specifications;

Plans shall govern over Supplemental Specifications and Standard Specifications;

Standard Special Provisions shall govern over Plans, Supplemental Specifications, and Standard Specifications; and

Project Special Provisions shall govern over Standard Special Provisions, Plans, Supplemental Specifications, and Standard Specifications.

The Contractor shall not take advantage of any apparent error or omission in the contract. In the event such errors or omissions are discovered the Engineer will make such corrections and interpretations as may be determined necessary for the fulfillment of the intent of the contract.

105-5 COOPERATION BY CONTRACTOR

The Contractor shall cooperate with the Engineer, his inspectors, and other contractors in every way possible, and shall give the work the constant attention necessary to facilitate the progress and satisfactory performance thereof. The Contractor shall notify the Engineer in writing at least 7 calendar days prior to beginning work on the project. He shall notify the Engineer at least 1 calendar day in advance when work is to be suspended and at least 2 calendar days in advance when work is to be resumed.

The Contractor shall keep available on the project site a copy of the contract assembly at all times.

105-6 SUPERVISION BY CONTRACTOR

(A) On Site Personnel

At all times that work is actually being performed, the Contractor shall have present on the project one competent individual who has been authorized to act in a supervisory capacity over all work on the project including work subcontracted. The individual who has been so authorized shall be experienced in the type of work being performed and is to be fully capable of managing, directing, and coordinating the work, of reading and thoroughly understanding the contract, and of receiving and carrying out directions from the Engineer or his authorized representatives. He shall be an employee of the Contractor, unless otherwise approved by the Engineer.

(B) On Call Personnel

At all times during the life of the project the Contractor shall provide one permanent employee who shall have the authority and capability for the overall responsibility of the project and who shall be personally available at the site of work within 24 hours notice. Such employee shall be fully authorized to conduct all business with the subcontractors, to negotiate and execute all supplemental agreements, and to execute the orders or directions of the Engineer.

(C) Exceptions

If the Contractor elects to have the employee described under (B) above constantly available in person on the project, then the presence of this employee will be considered as also meeting the requirements of (A) above. However, whenever such

employee is absent from the project then an authorized individual meeting the requirements of (A) above shall be present on the project.

105-7 COOPERATION BETWEEN CONTRACTORS

The Department reserves the right at any time to contract for and perform other or additional work on or near the work covered by the contract.

When separate or additional contracts are let within the limits of any one project, each Contractor shall conduct his work so as not to interfere with or hinder the progress or completion of the work being performed by other contractors. Contractors working within the limits of the same project shall cooperate with each other.

Each Contractor shall conduct his operations in such a manner as to avoid damaging any work being performed by others or which has been completed by others.

When a project is let under more than one contract and the plans and/or special provisions include a construction schedule, it shall be the responsibility of the Contractors to complete the various phases of the project in accordance with the time limits specified such that the total contracts will be completed by the completion date. This construction schedule will remain in effect until such time as the Contractors, at their option submit to the Engineer a joint construction schedule meeting the approval of the Engineer. This joint construction schedule shall be signed by authorized representatives of each firm and upon the approval of the Engineer shall be binding on each firm. Subsequent modifications to the joint construction schedule may be made during the course of the work in the same manner.

Failure of the Contractor(s) to complete the various phases of work within the time limits set forth in the construction schedule or latest approved joint construction schedule shall be just cause for removing the contractor(s) from the Department's list of qualified bidders. A contractor disqualified from bidding by reason of this provision will not be reinstated until such time as his progress is in accordance with the latest approved construction schedule or until the project is completed and accepted, whichever occurs first.

The Department will under no circumstances be liable for any claim for additional compensation due to acts of one contractor holding up the work of another.

The Department will under no circumstances be liable for any damages experienced by one Contractor as a result of the presence and operations of other contractors working within the limits of the same project.

105-8 COOPERATION WITH UTILITY OWNERS

Prior to the beginning of construction, the Department will notify all utility owners known to have facilities affected by the construction of the project and will make arrangements for the necessary adjustments of all affected public or private utility facilities. The utility adjustments may be made either before or after the beginning of construction of the project. The adjustments will be made by the utility owner or his representative, or by the Contractor when such adjustments are part of the work covered by his contract.

The Contractor shall use an independent utility locating service to locate utilities. The Contractor shall use special care working in, around and near all existing utilities that are encountered during construction, protecting them where necessary so that they will give uninterrupted service.

The Contractor shall cooperate with the utility owner, and/or the owner's representative in the adjustment or placement of utility facilities when such adjustment or placement is made necessary by the construction of the project or has been authorized by the Department.

In the event that utility services are interrupted by the Contractor, the Contractor shall promptly notify the owners and shall cooperate with the owners and/or the owner's representative in the restoration of service in the shortest time possible.

Existing fire hydrants shall be kept accessible to fire departments at all times.

Prior to submitting his bid, the Contractor shall make his own determination as to the nature and extent of the utility facilities, including proposed adjustments, new facilities, or temporary work to be performed by the utility owner or his representative; and as to whether or not any utility work is planned by the owner in conjunction with the project construction. The Contractor shall consider in his bid all of the permanent and temporary utility facilities in their present or relocated positions, whether or not specifically shown on the plans or covered in the project special provisions. It will be the Contractor's responsibility to anticipate any additional costs to him resulting from such utility work and to reflect these costs in his bid for the various items in the contract.

No additional compensation except as provided for in Article 104-4 will be allowed for delays, inconvenience, or damage sustained by the Contractor due to any interference from said utility facilities or the operation of moving them and any such delay, inconvenience, or damage except as provided for in Article 104-4 shall not constitute a basis for a claim for additional compensation.

Where changes to utility facilities are to be made solely for the convenience of the Contractor, it shall be the Contractor's responsibility to arrange for such changes and the Contractor shall bear all costs of such changes.

105-9 CONSTRUCTION STAKES, LINES, AND GRADES

Unless otherwise required in the contract, the Engineer will set construction stakes establishing lines, slopes, and continuous profile-grade in road work, and centerline and bench marks for bridge work, culvert work, protective and accessory structures, and appurtenances which require the use of an engineer's level and transit and will furnish the Contractor with all necessary information relating to lines, slopes, and grades. These stakes and marks shall constitute the field control by, and in accordance with which, the Contractor shall establish other necessary controls and perform the work.

The Contractor shall be held responsible for the preservation of all stakes and marks, and if any of the construction stakes or marks have been carelessly or willfully destroyed or disturbed by the Contractor, the cost of replacing them will be charged against him and will be deducted from the payment for the work.

105-10 AUTHORITY AND DUTIES OF THE INSPECTOR

Inspectors employed by the Department are authorized to inspect all work performed and materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. The inspector is not authorized to alter or waive the requirements of the contract. The inspector is not authorized to issue instructions contrary to the contract, or to act as foreman for the Contractor; however, he has the authority to reject work or materials until any questions at issue can be

referred to and decided by the Engineer. The inspector is not authorized to make any final acceptance of the work.

105-11 INSPECTION OF WORK

All materials and each part or detail of the work shall be subject to inspection by the Engineer. The Contractor shall allow and provide a reasonable access to all parts of the work to the Engineer or his authorized representative. The Contractor shall also furnish such information and assistance as is required to make a complete and detailed inspection. Such access shall meet the approval of the Engineer.

The presence of the Engineer or inspector at the work site shall in no way lessen the Contractor's responsibility for conformity with the contract. Should the Engineer or Inspector, prior to or during construction, fail to point out or reject materials or work that does not conform with the contract, whether from lack of discovery or for any other reason, it shall in no way prevent later rejection or corrections to the unsatisfactory materials or work when discovered. The Contractor shall have no claim for losses suffered due to any necessary removals or repairs resulting from the unsatisfactory work.

If the Engineer requests it, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. The Contractor shall keep cost records of the work performed and if the uncovered work is found to be acceptable, the Department will pay the Contractor on a force account basis in accordance with Article 109-3 for the cost of uncovering, or removing, and the replacing of the covering or making good of the parts removed; but should the work so exposed or examined prove unacceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed, shall be at no cost to the Department.

When any other unit of government or political subdivision is to pay a portion of the cost of the work covered by the contract, its respective representatives shall have the right to inspect the work. When work is to be performed on the right of way of any railroad corporation or in proximity to other public utilities, the representatives of the railroad corporation and/or the public utilities shall have the right to inspect the work. Such inspection shall in no sense make any unit of government or political subdivision or any railroad corporation or public utility a party to the contract, and shall in no way interfere with the rights of either party thereunder.

105-12 UNAUTHORIZED WORK

No work shall be performed without established lines and grades except as otherwise permitted by the Engineer. Work performed contrary to the instructions of the Engineer or contrary to any approvals granted by the Engineer will be considered as unauthorized and may not be paid for under the requirements of the contract. Work performed beyond the lines shown on the plans or as given, except as herein specified, or any extra work performed without authority will be considered as unauthorized and may not be paid for under the requirements of the contract. Any of the above work so performed may be ordered removed, replaced, or repaired at no cost to the Department.

Upon failure on the part of the Contractor to comply promptly with any order of the Engineer made under the provisions of this article, the Engineer will have the authority to cause such unauthorized work to be removed and/or adjusted to conform to the requirements of the contract and to deduct the cost of removal and/or adjustment from any monies due or to become due the Contractor.

105-13 LIMITATIONS OF OPERATIONS

At any time when, in the opinion of the Engineer, the Contractor has obstructed, closed, or is conducting operations on a greater portion of the work than is necessary for the prosecution of the work so as to constitute a hazard to the general public or impair the function of the facility being constructed where traffic shall be maintained, the Engineer may require the Contractor to suspend such unnecessary operations or closures and to finish the portions on which work is in progress before starting work on additional portions of the work.

105-14 NIGHT WORK

Whenever the Contractor's operations are being conducted at night, the Contractor shall provide such artificial lighting as may be necessary to provide for safe and proper construction and to provide for adequate inspection of the work as described in Section 1413.

105-15 RESTRICTION OF LOAD LIMITS

The Contractor shall comply with all legal load restrictions in hauling equipment and materials on roads under the jurisdiction of the Department.

The Department has the right to place load limit restrictions on the load a Contractor may haul on any road or bridge in the vicinity of his contract. The Contractor, prior to bidding on a project, will be responsible for making his own investigations to determine the possibility of load limit restrictions being placed on any of the highways he plans to use for hauling purposes. The Contractor shall not be entitled to an extension of time or to compensation for any costs, inconvenience, delay, or any other adversity to the Contractor as the result of any reduction by the Department in load limit, or as the result of a refusal by the Department to raise load limits as hereinafter provided or under any other conditions, and any such reduction in load limit or refusal to raise load limits shall not constitute a basis for a claim for additional compensation.

Wherever load limit restrictions below the statutory legal load limit have been posted on any roads and/or bridges on the project or within the vicinity of the project, the Department may remove the load limit restrictions from such roads and/or bridges upon written request from the Contractor; and the Contractor thereafter will be allowed to haul up to the statutory legal limits over such roads and/or bridges, provided the Contractor enters into an agreement with the Department providing for:

(A) Maintenance by the Contractor of such roads in a condition satisfactory to the Engineer during the haul period.

(B) Repair by the Contractor of all damages to such roads after haul is completed to place them in a condition as good as they were prior to removal of the load limits.

(C) Furnishing bond by the Contractor in an amount determined by the Engineer for the roads. Furnishing a bond for the roads does not entitle the Contractor to exceed the posted load limits of any bridge.

(D) Assumption by the Contractor of all costs of strengthening any bridges that may be necessary in order to safely haul loads up to statutory legal limits. The Department will, upon request by the Contractor, make a determination as to the method and extent of strengthening required for the bridges and will advise the Contractor as to the amount of work to be done or an estimate of the charges for the work if performed by Department forces. When Department forces perform the work, the Contractor shall reimburse the Department in the amount of the actual charges for said work. When Contractor's forces perform the work, it shall be done in accordance with plans approved by the Engineer and under his inspection.

(E) Indemnification of the Department against any and all claims from third persons arising out of or resulting from the hauling operation or the maintenance, or lack of maintenance, of haul roads. Haul roads shall be maintained not only for the Contractor's hauling operations, but also for the use of the general public.

Equipment operated on proposed bridges shall comply with the following load restrictions.

Maximum axle load (lbs.)	36,000
Maximum axle load on tandem axles (lbs.)	30,000
Maximum gross load (lbs.)	90,000

The Contractor shall keep the bridge floor clean to reduce impact forces and place approved temporary guides on the bridge floor to position the wheel loads as nearly as possible over the bridge girders. Only one earth-moving vehicle shall be on a bridge at any time. Upon completion of hauling over each bridge, the Contractor shall clean the bridge floor, curbs and rails.

Regulations pertaining to size and weight will not apply to equipment used on the project provided the vehicles involved are not operated on pavement, completed base course, or structures.

105-16 FAILURE TO MAINTAIN THE PROJECT OR PERFORM EROSION CONTROL WORK

Failure on the part of the Contractor to comply with the requirements of Article 104-10 or to perform erosion control work as directed will result in the Engineer notifying the Contractor to comply with these Specifications. In the event that the Contractor fails to begin such remedial action or fails to begin erosion control work within 24 hours after receipt of such notice with adequate forces and equipment, the Engineer may proceed to have the work performed with other forces. No payment will be made to the Contractor for work performed by others. Any costs incurred by the Department for work performed by others as provided above in excess of the costs that would have been incurred had the work been performed by the Contractor will be deducted from monies due the Contractor on his contract.

105-17 INSPECTION AND ACCEPTANCE

Upon apparent completion of the entire project, the Engineer will inspect the project for final acceptance. If all construction provided for and contemplated by the contract is found to be satisfactorily completed, the project will be accepted. The acceptance of projects in their entirety will not be altered except as listed below:

(A) When any continuous project is equal to or in excess of 5 miles in length, the Department will accept the project in 2 increments with the first increment equaling at least 50 percent of the total length of the project.

(B) Under resurfacing contracts, the Department will accept the project in parts as defined by map numbers representing at least 25% of the total length of project.

(C) When it is considered to be in the best interest of the Department, other increments or parts of projects may be considered for acceptance.

(D) When the contract contains an intermediate completion date requiring the completion of a portion of the work in its entirety, such portion of the work may be accepted if requested in writing by the Contractor.

(E) Bridge decks and rails that have been constructed or rehabilitated at such time as when they are open to public traffic.

(F) Permanent sign panels, including hardware and retroreflective sheeting, that are required prior to the final acceptance of the project by the Traffic Control Plans or by the Engineer when the roadway where the signs are located is open to public traffic.

Acceptance of any increment or part of a project shall not operate to waive the assessment of all or any portion of liquidated damages assessable under the terms of the contract.

When the inspection discloses any work, in whole or in part, as being unsatisfactory or incomplete, the Engineer will advise the Contractor of such unsatisfactory or incomplete work, and the Contractor shall immediately correct, repair, or complete such work. The project will not be accepted and the Contractor shall be responsible for the maintenance of the project and maintenance of traffic until all of the recommendations made at the time of the inspection have been satisfactorily completed.

The Engineer will notify the Contractor in writing that the project has been accepted as soon as practicable after the completion of the project. When an observation period(s) is required that extends beyond the final acceptance date, the satisfactory completion of the observation period(s) shall be covered by the contract bonds.

SECTION 106
CONTROL OF MATERIAL

106-1 GENERAL REQUIREMENTS

(A) GENERAL

The materials used on the work shall meet all requirements of the contract and shall be subject to inspection, test, or rejection by the Engineer at any time. Materials used in the work shall be new or recycled as permitted by the Specifications.

It is the Department's intent to expand the use of recovered materials in its construction programs. The Contractor is encouraged to find innovative and

alternative ways for beneficial use of recyclable materials that are currently a part of the solid waste stream and that contribute to problems of declining space in landfills.

The Contractor shall make his own determination of the various kinds and quantities of materials that are necessary for the acceptable performance and timely completion of the work. It will be the Contractor's responsibility to obtain materials that will meet the requirements of the contract. The Contractor shall be responsible for the acceptability of all materials used in the work and for the timely delivery of materials to the project so that adequate time will be available for the safe and proper performance of the work.

In order to facilitate testing by the Department, the Contractor shall furnish a complete statement of the origin of all materials to be used in the construction of the work, together with samples when required. The statement of origin shall be furnished to the Materials and Tests Unit sufficiently in advance of any shipment and/or fabrication of materials so that arrangements can be made for proper inspection.

The Contractor shall furnish a material safety data sheet with all paints and hazardous chemicals proposed for use on the project. The material safety data sheet shall be in accordance with the North Carolina Hazard Communication Standard (13 NCAC 7CF.0101.(a)(99)).

The Contractor shall provide access, means, and assistance in the verification of all testing equipment, scales, measures, and other devices operated by him in connection with the testing of the materials.

If the Contractor desires or is required to furnish materials from local deposits, other than those, if any, described in the contract he shall assume full responsibility for the sampling of the sources and the acceptability of the material in accordance with these specifications. He shall furnish without charge such preliminary samples as may be required; except that, if requested in writing, the Engineer may allow Department forces to take samples as requested by the Contractor. In the latter case, the Contractor shall reimburse the Department for the total expense of the sampling as determined by the Engineer. Tests will be made and reports rendered, but it is understood that such tests shall in no way be construed as a guarantee of acceptance of any material that may be delivered later for incorporation in the work. The Contractor shall assume full responsibility for the production of uniform and satisfactory materials from such local deposits, and shall indemnify and save harmless the Department from any and all claims for loss or damages resulting from the opening and operation thereof, or from the failure of the deposit after development to produce materials acceptable to the Engineer, in either quality or quantity.

(B) DOMESTIC STEEL

All steel and iron products which are permanently incorporated into this project shall be produced in the United States except minimal amounts of foreign steel and iron products may be used provided the combined project cost of the bid items involved does not exceed 0.1 percent of the total amount bid for the entire project or $2,500.00, whichever is greater. This minimal amount of foreign produced steel and

iron products permitted for use is not applicable to fasteners. Domestically produced fasteners are required for this project.

All steel and iron products furnished as domestic products shall be melted, cast, formed, shaped, drawn, extruded, forged, fabricated, produced, or otherwise processed and manufactured in the United States. Raw materials including pig iron and processed pelletized and reduced iron ore used in manufacturing domestic steel products may be imported; however, all manufacturing processes to produce the products, including coatings, shall occur in the United States.

Before each steel or iron product is incorporated into this project or included for partial payment on a monthly estimate, the Contractor shall furnish the Resident Engineer a notarized certification certifying that the product conforms to the above. The Engineer will forward a copy of each certification to the Materials and Tests Unit.

Each purchase order issued by the Contractor or a subcontractor for steel and iron products to be permanently incorporated into this project shall contain in bold print a statement advising the supplier that all manufacturing processes to produce the steel or iron shall have occurred in the United States. The Contractor and all affected subcontractors shall maintain a separate file for steel products permanently incorporated into this project so that verification of the Contractor's efforts to purchase domestic steel and iron products can readily be verified by an authorized representative of the Department or the Federal Highway Administration.

106-2 SAMPLES, TESTS, AND CITED SPECIFICATIONS

All tests will be made in accordance with the most recent standard or interim methods of the AASHTO in force on the date of advertisement. Should no AASHTO method of test exist for a material, the most recent standard or tentative method of ASTM or other methods adopted by the Department will be used.

All reference made to a specification published by AASHTO, ASTM, or any other organization other than the Department, which does not indicate the date of publication, will be understood to mean the specification current on the date of advertisement for the project. When a more current specification is published during the life of the project, and when it is mutually agreed by the Contractor and the Engineer and such agreement is documented by a supplemental agreement, the Department may accept materials meeting the requirements of the latest publication.

106-3 CONTRACTOR FURNISHED CERTIFICATION

The Contractor shall furnish the Department material certifications obtained from the producer, supplier, or an approved independent testing laboratory for the following types of materials, unless otherwise directed by the Engineer.

(A) Materials required to meet criteria documented by tests that are normally performed during the production process.

(B) Materials that are required to meet specifications other than those published by AASHTO, ASTM, or the Division of Highways.

(C) Materials produced at locations that are not within routine travel distance for Department representatives.

(D) Materials required to meet criteria documented by tests involving special equipment not readily available to Department representatives.

(E) Any other special material when so directed by the Engineer.

(F) Material certifications of one of the following types shall be furnished for pre-tested materials. The specific type of material certification for each material shall be in accordance with the schedule maintained by the Materials and Tests Unit. Copies of this schedule may be obtained from the Materials and Tests Unit.

Type 1 - Certified Mill Test Report

A certified mill test report shall be a certified report of tests conducted by the manufacturer on samples taken from the same heat or lot number as the material actually shipped to the project. The report shall identify the heat or lot number.

Type 2 - Typical Certified Mill Test Report

A typical certified mill test report shall be a certified report of tests conducted by the manufacturer on samples taken from a lot which is typical of the material actually shipped to the project, but which may or may not be from the lot shipped.

Type 3 - Manufacturer's Certification

A manufacturer's certification shall be a certified statement that the material actually shipped to the project was manufactured by production processes which are periodically and routinely inspected to assure conformance to specification requirements.

Type 4 - Certified Test Reports

A certified test report shall be a certified report of test conducted by an approved independent testing laboratory on samples taken from same heat or lot number as the material actually shipped to the project. The report shall identify the heat or lot number.

Type 5 - Typical Certified Test Reports

A certified test report shall be a certified report of tests conducted by an approved independent testing laboratory on samples taken from a lot which is typical of the material actually shipped to the project, but which may or may not be from the lot shipped.

Type 6 - Supplier's Certification

A supplier's certification is a signed statement by the supplier that the material described in the certification is of the specification grade required and that the supplier has on hand Type 1, Type 2, or Type 3 material certifications to cover the material which is included in the Type 6 supplier's certification.

Type 7 - Contractor's Certification

Contractor's certification is a signed statement by a contractor that the used material described in the certification meets the requirements of the current specifications to the best of the contractor's knowledge and that the contractor had in his possession at the time of purchase a Type 1, 2, or 3 materials certification to cover the material which is included in the Type 7 Contractor's Certification.

106-4 DELIVERY AND HANDLING OF MATERIALS

All materials shall be handled carefully and in such manner as to preserve their quality and fitness for the work. Materials damaged during delivery or handling shall not be used without approval of the Engineer.

106-5 STORAGE OF MATERIALS

Materials shall be stored so as to insure the preservation of their quality and fitness for the work. Stored materials, which may have been approved before storage, shall be subject to inspection at any time, and shall meet the requirements of the specifications at the time they are put into use. Stored materials shall be so located as to facilitate their inspection. Subject to the approval of the Engineer, that portion of the right of way not required for public travel may be used for storage purposes and for the Contractor's plant and equipment, but any additional space required therefor shall be provided by the Contractor at no expense to the Department. All storage sites located within the right of way shall be restored to their original condition by the Contractor at no expense to the Department, except where the materials stored are or are to become the property of the Department.

106-6 INSPECTION AT SOURCE

The Engineer may undertake the inspection of materials at the source of supply. This inspection will be performed by Department personnel or private organizations retained by the Department. Where approved by the Engineer, the results of tests performed by private laboratories, producers, or manufacturer's laboratories may be used in determining compliance of a material or product with the specifications.

The Department assumes no obligation to inspect materials at the source of supply and such inspection will be undertaken only upon condition that:

(A) The cooperation and assistance of the Contractor and the producer with whom he has contracted for materials is assured.

(B) The representative of the Engineer will have full entry at all times to such parts of the plant as may concern the manufacture or production of the materials.

(C) Laboratory facilities shall be provided when required by the Engineer.

Where the Department agrees to inspect or test materials during their production or at the source of supply, the Contractor shall bear the cost of testing performed on materials ordered by him but not incorporated into the project.

The Department reserves the right to retest all materials which have been tested and accepted at the source of supply after the same have been delivered, and to reject all materials which, when retested, do not meet the requirements of the specifications.

106-7 SCALES AND PUBLIC WEIGHMASTER

When material is to be paid for on a ton basis, the Contractor shall furnish platform scales or other weighing devices which have been certified by the N. C. Department of Agriculture. If the platform scales or other weighing devices are located outside of North Carolina, they shall have been certified by the Department of Agriculture within the particular state. The scales may be constructed and operated to provide automatic weighing, recording, and printing of tickets for the load being weighed.

The Department may deny or withhold any portion of payment for any load of materials weighed if in relation to such load of materials, the Contractor falsifies any weighing certification information or otherwise fails to comply with the requirements contained in this contract.

All scales shall be operated by a public weighmaster licensed in accordance with *Chapter 81A of the General Statutes of North Carolina*. A certified weight certificate shall be issued by a North Carolina public weighmaster for each load. The certificate shall be in the form of a ticket furnished by the Contractor and shall contain the following information:

(A) Division of Highways contract number

(B) Date

(C) Time issued, if for bituminous plant mix or portland cement stabilized base course mixed in a central plant

(D) Type of material

(E) Gross weight

(F) Tare weight

(G) Net weight of material

(H) Quarry or plant location

(I) Division of Highways' Job Mix Formula Number, if ticket is for asphalt plant mix

(J) Division of Highways' Asphalt Plant Certification Number, if ticket is for asphalt plant mix

(K) Truck number

(L) Contractor's name

(M) Public weighmaster's stamp or number

(N) Public weighmaster's signature or initials

When certified weighing devices other than platform scales are to be used, the gross weight and tare weight will not be required.

The Engineer may direct the Contractor to re-weigh the contents of any truck load that is to be delivered to the work on approved platform scales at no cost to the Department.

When tractor and trailer units are to be utilized in hauling material to be weighed, the platform scales shall be of sufficient length so as to accommodate the entire unit or the tractor shall be disconnected and the trailer and its contents weighed as a separate unit.

106-8 DEPARTMENT FURNISHED MATERIAL

The Contractor shall furnish all materials necessary to complete the work, except those materials specified in the contract to be furnished by the Department. Payment at the

contract price for the item which includes the use of Department furnished material will be full compensation for all costs of handling and placing such materials after they are delivered or made available to the Contractor.

The Contractor will be held responsible for all material furnished to him, and deductions will be made from any money due him to make good any shortage and deficiencies from any cause whatsoever and for any damage which may occur after Department furnished material has been made available.

106-9 DEFECTIVE MATERIAL

All materials which are not in reasonably close conformity to the requirements of the specifications shall be considered as defective and such materials, whether in place or not, shall be rejected and are to be removed from the site of the work unless otherwise permitted by the Engineer in accordance with Article 105-3. No rejected material, the defects of which may have been substantially corrected, may be used until approval has been given by the Engineer.

106-10 DENSITY DETERMINATION BY NUCLEAR METHODS

Application:

The Engineer may, at his option, use nuclear methods as described in Article 520-9 and 610-10 to determine the density of selected pavement materials. The use of nuclear methods will include the establishment of the required density through the use of control strips constructed from materials actually being used on the project, and the determination of the density being obtained in test sections located throughout the project.

SECTION 107
LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

107-1 LAWS TO BE OBSERVED

The Contractor shall keep himself fully informed of all Federal and State laws, all local laws, ordinances, and regulations, and all orders and decrees of bodies or tribunals having any jurisdiction or authority which may in any manner affect those engaged or employed in the work or which in any way affect the conduct of the work. He shall at all times observe and comply with all such laws, ordinances, regulations, orders, and decrees; and shall indemnify and hold harmless the Board of Transportation and the Department of Transportation and their agents and employees from any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, or decree, by the Contractor or by his agents and employees.

Comply with all Federal, State and local regulations when performing building removal and/or asbestos removal and disposal. Any fines resulting from violations of any regulation are the sole responsibility of the Contractor and the Contractor agrees to indemnify and hold harmless the Department against any assessment of such fines.

107-2 ASSIGNMENT OF CLAIMS VOID

In accordance with G.S. 143-3.3, the Department will not recognize any assignment of claims by any Contractor against the Department.

107-3 PERMITS AND LICENSES

The Contractor shall procure all permits and licenses except as otherwise specified; pay all charges, fees, and taxes; and give all notices necessary and incident to the due and lawful prosecution of the work.

For asphalt plants and concrete batch plants located on Department rights-of-way, apply for and obtain all environmental permits and licenses, including stormwater permits, for plants prior to placement within the project limits or elsewhere on NCDOT rights-of –way. Use proven Best Management Practices and equip all plants with such pollution control equipment and devices as is necessary to meet all applicable local, State and Federal pollution requirements. Conduct compliance monitoring and report findings to each applicable environmental regulatory agency according to their required frequency.

107-4 PATENTED DEVICES, MATERIALS, AND PROCESSES

If the Contractor employs any design, device, material, or process covered by letters of patent or copyright, he shall provide for such use by suitable legal agreement with the patentee or owner. The Contractor and his surety shall indemnify and save harmless the Department from any and all claims for infringement by reason of the use of such patented design, device, material, process, trademark, or copyright, and shall indemnify and save harmless the Department from any costs, expenses, and damages which it may be obligated to pay at any time during the prosecution or after the completion of the work by reason of any infringement.

107-5 ENCROACHMENT ON RIGHT OF WAY

Any individual, firm, or corporation wishing to encroach on highway right of way shall secure a written permit from the Department. The Contractor is not authorized to allow any individual, firm, or corporation to perform any work within the limits of the project unless such work has been authorized in writing by the Engineer.

When so directed by the Engineer, the Contractor shall make any repairs necessary due to such encroachments and such work will be paid for as extra work.

107-6 FEDERAL PARTICIPATION

When the United States Government pays all or any portion of the cost of the work, the Federal laws authorizing such participation and the rules and regulations made pursuant to such laws shall be observed by the Contractor. The work will be subject to the inspection of the representative of such Federal agencies as are created for the administration of these laws. The Contractor shall have no right to make the Federal Government a party to any court action solely by reason of its participation in the cost of the work or by reason of its inspection of the work.

107-7 SANITARY PROVISIONS

Provide and maintain in a neat, sanitary condition such accommodations for the use of employees as may be necessary to comply with the requirements of the State and local

Board of Health, or of other bodies or tribunals having Control and manage disposal of sanitary waste such that no adverse impacts occur to water quality.

107-8 PUBLIC CONVENIENCE AND SAFETY

The Contractor shall at all times so conduct his work as to insure the least possible obstruction to traffic. The safety and convenience of the general public and the residents along the highway, and the protection of persons and property, shall be provided for by the Contractor as specified in Section 150.

107-9 COORDINATION WITH RAILWAY

All work to be performed by the Contractor on railway right of way shall be performed in accordance with the contract and in a manner satisfactory to the railway company, and shall be performed at such times and in such manner as not to unnecessarily interfere with the movement of traffic upon the track of the railway company. The Contractor shall use all care and precautions in order to avoid accidents, damage, or unnecessary delays or interference with the railway company's traffic or other property. The Contractor shall carry such railroad protective insurance and public liability and property damage insurance as may be stipulated in the contract.

When the Contractor is required by the contract to transport materials or equipment across the tracks of any railway or to perform work on railway right of way, the Department will obtain any necessary written authority from the railway company for the establishment of a railway crossing or for the performance of work on railway right of way. The Contractor will not be required to bear the cost of any watchman service or flagging protection necessary due to such operations, as the railway company will be reimbursed directly by the Department for the cost of such work.

In case the Contractor elects or finds it necessary to transport materials or equipment across the tracks of any railway at any point where a crossing is not required by the contract or at any point other than an existing public crossing, he shall obtain specific written authority from the railway company for the establishment of a private railway crossing and shall bear all costs in connection with such crossing, including installation, drainage, maintenance, any necessary insurance, watchman service, flagging protection, and removal of such private railway crossing.

107-10 WORK IN, OVER, OR ADJACENT TO NAVIGABLE WATERS

All work in or over navigable waters shall be in accordance with conditions contained in the permit obtained by the Department from the authority granting the permit. These conditions will be included in the contract. The work shall be performed in such manner so as not to interfere with navigation of the waterway unless approval therefor is obtained from the authority granting the permit.

The Contractor shall prepare drawings necessary to obtain any addenda which may be required for his operations which are not included in the Department's permit. He shall coordinate their submission with the Engineer.

107-11 USE OF EXPLOSIVES

When the use of explosives is necessary for the prosecution of the work, the Contractor shall exercise the utmost care not to endanger life or property. The Contractor shall be

responsible for any and all damage or injury to persons or property resulting from the use of explosives. Such responsibility shall include, but shall in no way be limited to all damages arising from all forms of trespass to adjacent property as a result of blasting by the Contractor. The Contractor will not be held responsible for damage to adjacent landowner's wells or springs provided the Contractor has used reasonable care and has taken reasonable precautions to prevent such damage.

All explosives shall be stored in a secure manner, in compliance with all laws, and all such storage places shall be marked clearly *DANGEROUS EXPLOSIVES*.

The Contractor shall notify each public utility company having facilities in close proximity to the site of the work of his intention to use explosives. This notice shall be given sufficiently in advance to enable the utility companies to take whatever steps they may consider necessary to protect their property from injury. The Contractor shall also give the Engineer, all occupants of adjacent property, and all other contractors working in or near the project notice of his intention to use explosives. Motorists shall be notified in accordance with Article 1101-10.

The Contractor shall submit a blasting plan to the Engineer within 24 hours after each shot. The blasting plan shall contain the full details of the drilling and blasting patterns unless otherwise approved by the Engineer, and shall contain the following information:

(A) station limits of shot,

(B) plan of drill hole pattern, blast hole spacing, blast hole diameters and free face,

(C) initiation sequence of blastholes including delay timers and delay system,

(D) manufacturers' data sheet for all explosives, primers, and initiators employed,

(E) loading diagram showing type and amount of explosives, primers, initiators, and location and depth of stemming.

The blasting plan submitted is for quality control and record keeping purposes. Review by the Engineer shall not relieve the Contractor of his responsibilities as provided in Article 107-12.

107-12 PROTECTION AND RESTORATION OF PROPERTY

The Contractor shall be responsible for the protection from his activities of all public and private property on and adjacent to the work and shall use every reasonable precaution necessary to prevent damage or injury thereto. He shall use suitable precautions to prevent damage to pipes, conduits, and other underground structures, and to poles, wires, cables, and other overhead structures.

The Contractor shall protect carefully from disturbance or damage all land monuments and property markers until the Engineer has witnessed or otherwise referenced their location and shall not remove them until directed.

The Contractor shall be responsible for the removal, preservation, and resetting of all mailboxes disturbed by the construction operations. The mailboxes and their supports, when reset, shall be left in as good a condition as they were before removal. The Contractor will not be required to furnish new material except as required to repair damage resulting from construction operations.

The Contractor will be held responsible for all damage or injury to property of any character resulting from any act, omission, negligence, or misconduct in the prosecution of the work. When any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, negligence, or misconduct in the execution of the work, he shall either restore at his own expense such property to a condition similar or equal to that existing before such damage or injury was done, or shall make good such damage or injury in a manner acceptable to the owner of the damaged property and to the Department. In case of failure on the part of the Contractor to restore such property or make good such damage or injury the Department may at the Contractor's expense repair, rebuild, or otherwise restore such property in such manner, as the Engineer may consider necessary.

107-13 CONTROL OF EROSION, SILTATION, AND POLLUTION

(A) General

The Contractor shall take whatever measures are necessary to minimize soil erosion and siltation, water pollution, and air pollution caused by his operations. The Contractor shall also comply with the applicable regulations of all legally constituted authorities relating to pollution prevention and control. The Contractor shall keep himself fully informed of all such regulations that in any way affect the conduct of the work, and shall at all times observe and comply with all such regulations. In the event of conflict between such regulations and the requirements of the specifications, the more restrictive requirements shall apply.

The Engineer will limit the area over which clearing and grubbing, excavation, borrow, and embankment operations are performed whenever the Contractor's operations do not make effective use of construction practices and temporary measures which will minimize erosion, or whenever construction operations have not been coordinated to effectively minimize erosion, or whenever permanent erosion control features are not being completed as soon as permitted by construction operations.

Following completion of any construction phase or operation, on any graded slope or any area greater than one acre, the Contractor shall provide ground cover sufficient to restrain erosion within 21 calendar days or within a time period specified by the Sedimentation and Pollution Control Act. The ground cover shall be either temporary or permanent and the type specified in the contract.

(B) Erosion and Siltation Control

The Contractor shall exercise every reasonable precaution throughout the life of the project to prevent the eroding of soil and the silting of rivers, streams, lakes, reservoirs, other water impoundments, ground surfaces, or other property.

Prior to suspension of operations on the project or any portion thereof, the Contractor shall take all necessary measures to protect the construction area, including but not limited to borrow sources, soil type base course sources, and waste areas, from erosion during the period of suspension.

Unless otherwise approved in writing by the Engineer, construction operations in rivers, streams, and water impoundments shall be restricted to those areas where

channel changes are shown on the plans and to those areas which must be entered for the construction or removal of temporary or permanent structures.

Excavated materials shall not be deposited, nor shall earth dikes or other temporary earth structures be constructed, in rivers, streams, or impoundments. As an exception to the above, confined earth materials will be permitted when approved in writing by the Engineer.

Frequent fording of live streams with construction equipment will not be permitted; therefore, temporary bridges or other structures shall be used wherever frequent stream crossings are necessary. Unless otherwise approved in writing by the Engineer, mechanized equipment shall not be operated in live streams except as may be necessary to construct channel changes and to construct or remove temporary or permanent structures.

(C) Coordination of Erosion Control Operations

Temporary and permanent erosion control measures shall be provided as shown on the plans or as directed by the Engineer. All permanent erosion control work shall be incorporated into the project at the earliest practicable time. Temporary erosion control measures shall be coordinated with permanent erosion control measures and all other work on the project to assure economical, effective, and continuous erosion control throughout the construction and post construction period and to minimize siltation of rivers, streams, lakes, reservoirs, other water impoundments, ground surfaces, or other property.

Temporary erosion control measures shall include but not be limited to the use of temporary berms, dikes, dams, drainage ditches, silt basins, silt ditches, slope drains, structures, vegetation, mulches, mats, netting, gravel, or any other methods or devices that are necessary. Temporary erosion control measures may include work outside the right of way or construction limits where such work is necessary as a result of construction such as borrow operations, haul roads, plant sites, equipment storage sites, and disposal of waste or debris. The Contractor shall be liable for all damages to public or private property caused by silting or slides originating in waste areas furnished by the Contractor.

Materials for temporary erosion control measures shall have been approved by the Engineer before being used or shall be as directed by the Engineer.

The Contractor shall acceptably maintain erosion control measures installed.

(D) Water and Air Pollution

Exercise every reasonable precaution throughout the life of the project to prevent pollution of ground waters and surface waters, such as rivers, streams, and water impoundments. Do not discharge onto the ground or surface waters any pollutants such as chemicals, raw sewage, fuels, lubricants, coolants, hydraulic fluids, bitumens, and any other petroleum products. Operate and maintain equipment on site in a manner as to prevent the potential or actual pollution of surface or ground waters of the State. Dispose of spent fluids in accordance with applicable State and Federal disposal regulations. Immediately clean up any spilled fluids to the extent practicable and dispose of properly.

Manage, control and dispose of litter on site such that no adverse impacts to water quality occur.

Comply with all State or local air pollution regulations throughout the life of the project.

(E) Dust Control

The Contractor shall control dust throughout the life of the project within the project area and at all other areas affected by the construction of the project, including, but not specifically limited to, unpaved secondary roads, haul roads, access roads, disposal sites, borrow and material sources, and production sites. Dust control shall not be considered effective where the amount of dust creates a potential or actual unsafe condition, public nuisance, or condition endangering the value, utility, or appearance of any property.

The Contractor will not be directly compensated for any dust control measures necessary, as this work will be considered incidental to the work covered by the various contract items.

(F) Application of Specifications

The requirements of this article shall apply to all construction operations. Further references and detailed requirements concerning erosion, siltation, and pollution prevention and control are given in other sections of the Specifications as supplements to the general requirements of this article.

(G) Sanctions

In the event that temporary erosion and pollution control measures become necessary due to the Contractor's negligence, carelessness, or failure to incorporate permanent erosion control measures into the project at the earliest practicable time, such measures shall be performed by the Contractor as directed by the Engineer at no cost to the Department. If the Contractor fails to perform such measures as directed, the Engineer may have the work performed in accordance with Article 105-16.

Failure of the Contractor to fulfill any of the requirements of this article may result in the Engineer ordering the stopping of construction operations in accordance with Article 108-7 until such failure has been corrected. Such suspension of operations will not justify an extension of contract time.

Failure on the part of the Contractor to perform the necessary measures to control erosion, siltation, and pollution will result in the Engineer notifying the Contractor to take such measures. In the event that the Contractor fails to perform such measures within 24 hours after receipt of such notice with adequate forces and equipment, the Engineer may suspend the work as provided above, or may proceed to have such measures performed with other forces and equipment, or both. No payment will be made to the Contractor for the performance of this work and the cost of such work so performed will be deducted from monies due the Contractor on his contract.

107-14 PROTECTION OF PUBLIC LANDS

In the execution of any work within or adjacent to any State or National forest, park, or other public lands, the Contractor shall comply with all regulations of all authorities having jurisdiction over such forest, park, or lands, governing the protection of public lands and the carrying out of work within public lands, and shall observe all sanitary laws and regulations with respect to the performance of work in public lands. He shall keep the areas in an orderly condition, properly dispose of all refuse, and obtain permits for the construction and maintenance of all construction camps, stores, warehouses, residences, latrines, cesspools, septic tanks, and other structures in accordance with the requirements of the appropriate authorities.

The Contractor shall take all reasonable precaution to prevent and suppress forest fires and shall require his employees and subcontractors, both independently and at the request of forest officials, to do all reasonable within their power to prevent and suppress and to assist in preventing and suppressing forest fires and to make every possible effort to notify a forest official at the earliest possible moment of the location and extent of any fire seen by them.

The Contractor shall obtain any construction permits that may be required for his operations, which are not a part of the project, in accordance with the requirements of the regulations of the appropriate authorities.

107-15 RESPONSIBILITY FOR DAMAGE CLAIMS

The Contractor shall indemnify and save harmless the Board of Transportation and its members and the Department of Transportation and its officers, agents, and employees from all suits, actions, or claims of any character brought for any injury or damages received or sustained by any person, persons, or property by reason of any act of the Contractor, subcontractor, its agents or employees, in the performance of the contract. The Contractor's liability to save harmless and indemnify shall include, but not by way of limitation, the following:

(A) damages or claims for the failure of the Contractor to safeguard the work;

(B) damages or claims by reason of the failure of the Contractor to erect adequate barricades and post adequate warnings to the public of such barricades;

(C) any damage or claims caused through the Contractor's use of defective materials or by the performance of defective work;

(D) any claims by reason of the Contractor's infringement of patent, trademark, or copyright;

(E) any amounts paid by the Department by reason of the Contractor's failure to comply with or for violations of laws, ordinances, orders, or decrees;

(F) any damages or claims caused by blasting operations of the Contractor with or without proof of negligence on the part of the Contractor;

(G) damages or claims caused by the failure of the Contractor to protect private or public property pursuant to Article 107-12, including damages to public and private property caused by silting and slides from waste areas furnished by the contractor, without proof of negligence;

(H) damages caused by the failure of the Contractor to control erosion in accordance with the contract.

In addition to any remedy authorized by law, the Department shall have a right to retain from monies due the Contractor, as the Department considers necessary until final disposition has been made of the following suits or claims:

(1) For all claims against the Department involving claims or damages that are the Contractor's responsibility under Section 107. The Contractor and the Surety shall remain responsible until such suits or claims against the Department have been settled and until the Department has been indemnified and saved harmless.

(2) In case of claims by the third parties against the Contractor involving tort liability for which the Department might be held liable for as a taking of property, or as a tort before the Industrial Commission. However, monies due the Contractor will not be retained provided the Contractor produces satisfactory evidence to the Department that he is adequately protected from such tort liability by public liability and property damage insurance. In all other cases involving claims or suits by third parties against the Contractor, amounts due the Contractor will not be withheld provided that the consent of the Surety is furnished and the Surety guarantees payment of any amounts for which the Contractor may be determined to be legally liable.

(3) In cases of damage to property of the Department, such amounts necessary to pay for such damage.

In cases where claims are made or suits filed against employees, agents, or officers of the Department of Transportation or members of the Board of Transportation, the Department of Transportation may retain from monies due the Contractor sufficient to indemnify such employee, agent, or officer of the Department of Transportation or member of the Board of Transportation for any amounts which they may be held liable for but for which the Contractor is responsible under the requirements of Section 107. In the event that there is not sufficient retainage or the final estimate is paid, the Department of Transportation may collect from the Contractor or its Surety amounts sufficient to indemnify such employee, agent, or officer of the Department of Transportation or member of the Board of Transportation for such damages incurred.

107-16 LIABILITY INSURANCE

When required by the contract, the Contractor shall carry insurance of the kinds and in the amounts specified therein in addition to any other forms of insurance or bonds required under the terms of the contract, or any other insurance carried by the Contractor.

107-17 OPENING SECTIONS OF PROJECT TO TRAFFIC

If it is determined by the Engineer that the Contractor will not complete the work by the completion date, intermediate completion date, or intermediate completion time, the Engineer may notify the Contractor in writing that upon expiration of contract time or intermediate contract time the project or any portion thereof will be open to traffic. On such sections that are opened, the Contractor shall conduct the remainder of his operations so as to cause the least obstruction to traffic. The Contractor shall not be relieved of his liability or responsibility, shall not receive any additional compensation due to the added cost of the work, nor shall he receive any extension of the completion date, intermediate completion date, or intermediate completion time, by reason of such openings.

107-18 CONTRACTOR'S RESPONSIBILITY FOR WORK

Until final acceptance of the work by the Engineer, as evidenced in writing, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part thereof by the action of the elements, or from any other cause, whether arising from the execution or from the nonexecution of the work. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof, except as provided in other sections of the Specifications. The Department will reimburse the Contractor for the repair of the work due to actions of the elements of such exceptional nature as to be legally classified as Acts of God.

In case of suspension of work from any cause whatever, the Contractor shall be responsible for all materials, and shall properly store them, if necessary, and shall provide suitable drainage of the roadway and erect necessary temporary structures at no cost to the Department.

107-19 FURNISHING RIGHT OF WAY

The Department will be responsible for the securing of all necessary rights of way in advance of construction.

107-20 PERSONAL LIABILITY OF PUBLIC OFFICIALS

Employees, agents, officers, and members of the Board of Transportation or the Department of Transportation shall not be held personally liable for any damages connected with the work, it being specifically understood in all such matters that they act solely as agents and representatives of the Board of Transportation or the Department of Transportation.

107-21 WAIVER OF LEGAL RIGHTS BY THE DEPARTMENT

Upon completion of the work, the Department will expeditiously make an inspection and notify the Contractor of acceptance. Such final acceptance and processing of the final estimate, however, shall not preclude or estop the Department from correcting any measurement, estimate, or certificate made before or after completion of the work, nor shall the Department be precluded or estopped from recovering from the Contractor or his Surety, or both, such overpayment as it may sustain, or by failure on the part of the Contractor to fulfill his obligations under the contract. A waiver on the part of the Department of any breach of any part of the contract shall not be held to be a waiver of any other or subsequent breach.

The Contractor, without prejudice to the terms of the contract, shall be liable to the Department for latent defects, fraud, or such gross mistakes as may amount to fraud, or as regards the Department's rights under any warranty or guaranty.

107-22 SAFETY AND ACCIDENT PROTECTION

The Contractor shall comply with all applicable Federal, State, and local laws, ordinances, and regulations governing safety, health, and sanitation, and shall provide all safeguards, safety devices, and protective equipment, and shall take any other needed actions, on his own responsibility that are reasonably necessary to protect the life and health

of employees on the job and the safety of the public, and to protect property in connection with the performance of the work covered by the contract.

All Contractors' personnel, all subcontractors and their personnel, and any material suppliers and their personnel shall wear a reflective vest or outer garment conforming to the requirements of MUTCD at all times while on the project.

107-23 WAGES AND CONDITIONS OF EMPLOYMENT

The Contractor's attention is directed to the provisions and requirements of any and all public statutes that regulate hours or conditions of employment on public work. Such provisions and requirements that are appropriate, in accordance with the intent of the particular law, act, or statute, will be applicable to all work performed by the Contractor with his own organization and with the assistance of workmen under his immediate superintendence, and to all work performed by subcontract. It shall be the responsibility of the Contractor to ascertain the appropriate application of such provisions and requirements to the work.

In addition to the general requirements of the various regulations referred to above, certain additional regulations and restrictions may be imposed that are peculiar to the particular work under the contract. In such cases, these regulations and restrictions will be included in the contract for the particular project involved.

For projects that are financed wholly or in part with Federal funds, the minimum wage rates to be paid to all mechanics and laborers employed on the project will be determined by the U.S. Secretary of Labor. A schedule of such wage rates will be inserted in the proposal for such projects. The Contractor shall provide at the job site at no cost to the Department a weatherproof bulletin board covered with glass or rigid transparent plastic and shall display thereon at all times legible copies of such schedule of wage rates and of the wage rate information poster that will be furnished to him. The bulletin board shall be located in a conspicuous place easily accessible to all employees.

In the event that changes should occur in any of the regulations referred to in this article, or in any application thereof to the work under contract, no additional compensation will be allowed the Contractor as a result of such changes.

107-24 LIABILITY TO THIRD PARTIES

It is not intended by any of the provisions of any part of these specifications to make the public or any member thereof a third party beneficiary hereunder, or to authorize anyone who is not a party to a contract entered into pursuant to these specifications to maintain a suit for personal injury or property damage otherwise than as authorized and provided by law.

107-25 RIGHT OF THE CONTRACTOR TO FILE VERIFIED CLAIM

If the Contractor fails to receive such settlement as he claims to be entitled to under the terms and provisions of the contract, the Contractor may submit a written and verified claim for such amounts he deems himself or his subcontractor(s) entitled to under the terms and provisions of the contract provided he has complied with the applicable provisions of the contract including, but not limited to, giving written notice of intent to file a claim, keeping and submission of cost records, and the initial submission of a written claim within the

specified time period. The claim shall be submitted to the State Highway Administrator within 60 days from the time the Contractor receives the final estimate as defined by Section 101 and shall be submitted in accordance with G.S. 136-29.

107-26 HAZARDOUS, CONTAMINATED, AND/OR TOXIC MATERIAL

When the Contractor's operations encounter or expose any abnormal condition that may indicate the presence of a hazardous, contaminated, and/or toxic material, such operations shall be discontinued in the vicinity of the abnormal condition and the Engineer shall be notified immediately. Upon notification by the Contractor, the Engineer will investigate the work and, if necessary, suspend the work in accordance with Article 108-7. The presence of barrels; old or abandoned underground storage tanks, and discolored earth, metal, wood, etc.; visible fumes; abnormal odors; excessively hot earth; smoke; or anything else that appears abnormal may be indicators of hazardous, contaminated, and/or toxic materials and shall be treated with extraordinary caution as they are evidence of abnormal conditions.

The Contractor's operations shall not resume until so directed by the Engineer.

Disposition of the hazardous, contaminated, and/or toxic material will be made in accordance with the requirements and regulations of the Department of Human Resources and the Department of Environment, Health & Natural Resources. Where the Contractor performs work necessary to dispose of hazardous, contaminated, and/or toxic material, payment will be made at the unit prices for pay items included in the contract which are applicable to such work or, where the contract does not include such pay items, payment will be made as provided in Article 104-7 for extra work. Where the contract does not include pay items for the work necessary to dispose of hazardous, contaminated, and/or toxic material, the Engineer may have the work performed by others.

107-27 FINES AND LEVIES AGAINST THE DEPARTMENT

In the event there are fines or charges levied against the Department, actions taken by the Department, or remediation required by the Department due to the contractor’s negligence, carelessness or failure, due to violations charged to the Contractor, or due to the Contractor’s failure to conform to the Specifications, monies will be deducted from monies to be paid to the Contractor on this project.

SECTION 108
PROSECUTION AND PROGRESS

108-1 GENERAL

It is the intent of these Specifications that the Contractor shall commence work on the date of availability shown in the contract or as soon thereafter as practicable, except that when required by permits included in the proposal, that work in jurisdictional waters and wetlands shall not begin until a meeting is held between the Department, Regulatory Agencies, and the Contractor. The Contractor shall not begin work prior to the date of availability without written approval of the Engineer. If such approval is given, the Department will assume no responsibility for any delays caused prior to the date of availability by any reason whatsoever, and such delays, if any, will not constitute a valid reason for extending the completion date.

The Contractor shall pursue the work diligently with workmen in sufficient numbers, abilities, and supervision, and with equipment, materials, and methods of construction as may be required to complete the work described in the contract or as may be amended, by the completion date.

108-2 PROGRESS SCHEDULE

The Contractor shall prepare and submit for approval by the Engineer a schedule of his proposed working progress on the project in accordance with the instructions and on forms furnished by the Engineer.

The proposed progress schedule shall be submitted no later than 7 days prior to the date of the project preconstruction conference and shall have been approved before any work is begun on the project.

When conditions beyond the Contractor's control have adversely affected his progress, or the Engineer has extended the completion date, the Contractor may submit a revised progress schedule to the Engineer for approval. Such revised progress schedule will not be approved unless accompanied by a detailed written statement giving the Contractor's reasons for the proposed revision.

108-3 PRECONSTRUCTION CONFERENCE

Immediately after receipt of notice of award, the Division Engineer and the Contractor will establish a mutually agreeable date on which the preconstruction conference will be held. The Contractor's project superintendent and other individuals representing the Contractor who are knowledgeable of the Contractor's proposed progress schedule or who will be in charge of major items of the work shall attend the preconstruction conference.

108-4 CONSTRUCTION CONFERENCES

After work on the project has begun, construction conferences shall be held periodically. The construction conferences are to be scheduled at times that are mutually agreeable to both the project superintendent and the Resident Engineer. It shall be the superintendent's responsibility to attend the conferences.

108-5 CHARACTER OF WORKMEN, METHODS, AND EQUIPMENT

The Contractor shall at all times employ sufficient labor and equipment for prosecuting the several classes of work to full completion in the manner and time required by these specifications.

The Contractor shall not recruit Department employees for employment. Additionally, Department employees who elect to become employed by a Contractor may not perform any function on a project with which they have been involved during employment with the Department without written consent of the State. Any person employed by the Contractor and assigned to a project who has previously been involved in the project as a Department employee shall be, at the written direction of the Engineer, removed from the project. An exception to these terms may be granted when recommended by the Secretary and approved by the Board of Transportation.

Failure of the contractor to comply may be justification for disqualifying the Contractor from further bidding in accordance with the requirements of Article 102-16 and shall be grounds for termination of this contract.

No person shall be employed by the Contractor or by any subcontractor who has been determined by the Engineer to have engaged in fraudulent activities in connection with any work for the Department of Transportation.

Any person employed by the Contractor or by any subcontractor who, in the opinion of the Engineer, does not perform his work in a proper and skillful manner or is disrespectful, intemperate, or disorderly or who has been determined by the Engineer to have engaged in fraudulent activities in connection with any work for the Department of Transportation shall be, at the written request of the Engineer, removed forthwith by the Contractor or subcontractor employing such person, and shall not be employed again in any portion of the work without the approval of the Engineer.

Should the Contractor fail to remove such person(s) as required above, the Engineer may suspend the work in accordance with the requirements of Article 108-7.

All equipment which is proposed to be used on the work is to be of sufficient size and in such mechanical condition as to meet the requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the project shall be such that no injury to the roadway, adjacent property, or other highways will result from its use. The Engineer may order in writing the removal and replacement of any unsatisfactory equipment.

When the methods and equipment to be used by the Contractor in accomplishing the construction are not prescribed in the contract, the Contractor is free to use any methods or equipment that he demonstrates to the satisfaction of the Engineer will accomplish the contract work in conformity with the requirements of the contract.

When the contract specifies that the construction be performed by the use of certain methods and equipment, such methods and equipment shall be used unless others are approved by the Engineer. If the Contractor desires to use a method or type of equipment other than those specified in the contract, he may request approval from the Engineer to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed to be used and an explanation of the reasons for desiring to make the change. If approval is given it will be on the condition that the Contractor will be fully responsible for producing construction work in conformity with contract requirements. If, after trial use of the substituted methods or equipment, the Engineer determines that the work produced does not meet contract requirements, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining construction with the specified methods and equipment. The Contractor shall remove the unsatisfactory work and replace it with work of specified quality, or take such other corrective action as the Engineer may direct. No change will be made in basis of payment for the construction items involved or in the completion date as a result of authorizing a change in methods or equipment under these provisions.

108-6 SUBLETTING OF CONTRACT

The Contractor shall not sublet, sell, transfer, assign, or otherwise dispose of the contract or any portion thereof; or of his right, title, or interest therein; without written consent of the

Engineer. In case such consent is given, the sublet work shall be performed by the subcontractor unless otherwise approved in writing by the Engineer. Failure of the Contractor to comply with these Specifications will be just cause for the work to be considered unauthorized in accordance with Article 105-12. A firm that has been disqualified due to its failure to maintain satisfactory progress under the requirements of Article 108-8 will not be approved as a subcontractor until the firm demonstrates the ability to perform the work in a satisfactory manner. When directed by the Engineer, the Contractor shall submit a certified copy of the actual subcontract agreement executed between the Contractor and subcontractor prior to written consent being issued by the Engineer. In case such consent is given, the Contractor will be permitted to sublet a portion thereof, but shall perform with his own organization, work amounting to not less than 40 percent of the total original contract amount, except:

(A) Any items designated in the contract as *specialty items* may be performed by subcontract and the cost of any such special items so performed by subcontract will be deducted from the total amount bid before computing the amount of work required to be performed by the Contractor with his own organization, and

(B) Any other items sublet to Disadvantaged Business Enterprise (DBE), Minority Business (MB) or Women's Business (WB), up to the value of the contract DBE, MB or WB goal, will be deducted from the total amount bid before computing the amount of work required to be performed by the Contractor with his own organization.

In any event, the Contractor shall perform with his own organization work amounting to not less than 35% of the difference between the total amount bid and the value of specialty items that have been sublet.

Extra work performed in accordance with Article 104-7 will not be considered in the computation of work required to be performed by the Contractor.

An assignment by operations of law or assignment for the benefit of creditors, or the bankruptcy of the Contractor, shall not vest any right in this contract in the Trustee in bankruptcy, the Contractor's creditors, or the agent of the creditors.

A subcontractor shall not sublet, sell, transfer, assign, or otherwise dispose of his contract with a contractor or any portion thereof; or of his right, title, or interest therein; without written consent of the Engineer. When directed by the Engineer, the contractor shall submit a certified copy of the actual subcontract agreement executed between the subcontractor and the second tier subcontractor. In the event of an assignment by operations of law or the bankruptcy of the subcontractor, the contractor shall have the right, power, and authority, in its discretion, without violating the contract or releasing the Surety, to terminate the subcontract. An assignment by operations of law or assignment for the benefit of creditors or the bankruptcy of the subcontractor shall not vest any right in this contract in the Trustee in bankruptcy, nor the subcontractor's creditors or agents of the creditors.

Neither the Contractor, nor any subcontractor, shall enter into any written or oral equipment lease or rental agreement, materials purchase agreement, and/or labor agreement that circumvents the requirements of this article.

If the Contractor or a subcontractor enter into a lease or rental agreement for equipment based upon payment for a unit of work, such agreement will be considered subletting of the contract unless the lease or rental agreement is with a commercial equipment company,

manufacturer, and/or commercial leasing agency and such firm has been approved by the Engineer. An equipment lease or rental agreement that is based upon unit prices per unit of time will not be considered subletting of the contract.

The approval of any subcontract will not release the Contractor of his liability under the contract and bonds, nor will the subcontractor or the second tier subcontractor have any claim against the Department by reason of the approval of the subcontract. The State Highway Administrator will review and consider subcontractor claims for additional time or compensation provided such claims are submitted by the contractor in accordance with Article 107-25 and General Statute 136-29.

Failure of the Contractor to comply with any of the requirements of this article may be justification for disqualifying the Contractor from further bidding in accordance with the requirements of Article 102-16.

108-7 TEMPORARY SUSPENSION OF THE WORK

The Engineer will have the authority to suspend the work wholly or in part by written order for such periods, as he may deem necessary for any of the following reasons:

(A) Conditions considered unfavorable for the suitable prosecution of the work, or

(B) The Contractor's failure to correct conditions unsafe for workmen or the general public, or

(C) The Contractor has not carried out orders given to him by the Engineer, or

(D) The Contractor's failure to perform any provisions of the contract.

No extension of the completion date will be allowed for the above suspensions except as may be provided for in Article 108-10.

108-8 FAILURE TO MAINTAIN SATISFACTORY PROGRESS

The Engineer will check the Contractor's progress at the time each partial pay estimate is prepared. The Contractor's progress may be considered as unsatisfactory as follows:

(A) The Contractor's progress is found to be less than that described in both counts below:

(1) The dollar value of the work completed, excluding material payments allowed by Article 109-5, is less than the dollar value of the work that should have been completed, on the basis of the Contractor's approved progress schedule, by more than 15 percent of the current contract amount.

The dollar value of the work completed will be the total estimate to date shown in the latest partial pay estimate, excluding material payments allowed by Article 109-5. The current contract amount will be the total amount bid plus accumulated overruns less accumulated underruns shown in the latest partial pay estimate.

(2) The percentage of the work completed is less than the percentage of contract time elapsed on the work by more than 15 percentage points. The percentage of work completed will be the dollar value of the work completed as defined above, divided by the current contract amount as defined above.

The percentage of contract time elapsed will be the number of calendar days elapsed as shown in the latest partial pay estimate divided by the total contract time in calendar days.

(B) The Contractor fails to begin and pursue the work in accordance with Article 108-1 prior to the expiration of 5% of the original contract time after the date work was scheduled to begin based upon the approved progress schedule.

(C) The Engineer anticipates the Contractor will not complete the work described in the contract by the intermediate contract time or the contract completion date.

When the Contractor's progress is found to be unsatisfactory as described above, the Engineer may make written demand of the Contractor to state in writing the reason for the unsatisfactory progress and produce such supporting data as the Engineer may require or the Contractor may desire to submit. The Engineer will consider the justifications submitted by the Contractor and extensions of the completion date have or may be allowed in accordance with Article 108-10(B).

When the Contractor cannot satisfactorily justify the unsatisfactory progress, the Engineer may invoke one or more of the following sanctions:

(A) Withhold anticipated liquidated damages from amounts currently due or that become due.

(B) Remove the Contractor and all firms prequalified under the Contractor's Prequalification Number from the Department's Prequalified Bidders List.

When any of the above sanctions have been invoked, they shall remain in effect until rescinded by the Engineer.

108-9 DEFAULT OF CONTRACT

(A) Declaration of Default

The Department shall have the right to declare default of the contract for breach by the Contractor of any material term or condition of the contract. Material breach by the Contractor shall include, but specifically shall not be limited to failure to begin work under the contract within the time specified; failure to provide workmen, equipment, or materials adequate to perform the work in conformity with the contract by the completion date; unsatisfactory performance of the work; refusal or failure to replace defective work; failure to maintain satisfactory work progress; failure to comply with equal employment opportunity contract requirements; insolvency or bankruptcy, or any act of insolvency or bankruptcy; failure to satisfy any final judgment within 10 calendar days after entry thereof; and making an assignment for benefit of creditors.

(B) Sanctions

In the event of a breach of the contract by the Contractor, the Department shall have the right, power, and authority, in its sole discretion, without violating the contract or releasing the surety: to assume full control of the prosecution of the contract in the place and stead of the Contractor in directing Contractor's agents, employees, and subcontractors in the performance of the work and in utilizing all materials, tools, machinery, equipment, and structures located on the project; to perform the work or

any part thereof with Department personnel and equipment or to utilize any or all materials and equipment located on the project that are suitable and acceptable; to relet the work upon such terms and conditions as the Department shall deem appropriate; to employ any other methods that it may determine are required for completion of the contract in an acceptable manner; and to withhold any sums due the Contractor under the contract without penalty or interest until the work is completed and accepted by the Department.

(C) Notice

Before invoking any of the sanctions provided for herein, the Department will give the Contractor at least 7 calendar days written notice with a copy to the Surety, that will set forth the breach of contract involved and the sanctions to be imposed. The Department, in its discretion, may grant the Contractor time in excess of 7 calendar days within which to comply with the contract and the time allowed will be set forth in writing. If the Department determines during such period that the Contractor is not proceeding satisfactorily to compliance, it may impose the sanctions after 24 hours notice to the Contractor. If the Department determines that the Contractor is not in compliance at the end of the time allowed, it may immediately impose any of the sanctions set forth herein and will advise the Contractor, in writing, with a copy to the Surety of the sanctions imposed.

(D) Payment

After declaration of default has been made final, the Contractor will be entitled to receive payment for work satisfactorily completed or portions of work satisfactorily completed, less any sums that may be due the Department from the Contractor but in no event shall payment exceed the contract unit or lump sum price for such work. The Department, at its election, may retain the sum due the Contractor, or any portion thereof, without interest or penalty, until the contract work is completed; or it may make payment to the Contractor upon declaration of default for work satisfactorily completed to the date that notice of default is received by the Contractor. The Contractor may be required by the Engineer, however, to carry to a stage of completion satisfactory to the Engineer any work in progress, the value of which otherwise would be lost by immediate cessation of work. Payment for such work will be made upon the basis hereinafter set out.

In the event that the Contractor's employees, equipment, or materials are used in prosecution of the work, or any part thereof, after default is declared, payment to the Contractor may be by contract unit or lump sum prices for the work performed, or, if the Engineer determines that such prices do not represent the value of the work performed, payment for the type of work or services performed will be made on a force account basis, as set forth in Article 109-3, less any sums that may be due the Department; but in no event shall payment exceed the contract unit or lump sum price for such work or services. Determination of the method of payment shall be in the sole discretion of the Engineer, and he will advise the Contractor, in writing, of his determination with reference to the specific type of work or service to be performed.

If all costs and expenses incurred by the Department arising out of the breach and imposition of sanctions, together with the total cost to the Department of securing the performance of the work set forth in the contract, exceed the sum that would have been payable under the contract, the Contractor and the Surety shall be liable to the Department for such excess and shall pay such amount to the Department.

(E) Power of Engineer

The Engineer will exercise the powers and discretion vested in him by the contract in carrying out the terms of this article. He will have full power and authority to carry out any orders, directives, or resolutions issued by the Department in connection with a declaration of default. In the event that the Department fails to specify the sanctions to be imposed, the notice to be given, or the method of completing the work, the Engineer, may, in his discretion, impose such sanctions, give such notice, and select such methods of completing the work, as are authorized by this article; and such actions shall have the same effect and validity as if taken pursuant to an express order, directive, or resolution of the Department.

(F) Obligation of Contractor and Surety

No term or terms of this article and no action taken pursuant hereto by the Department of Transportation, its agents, or employees, will be construed to release or discharge the Contractor or the Surety upon the obligation set forth in the contract bonds, and the Contractor and the Surety shall remain bound thereon unto the Department until the work set forth in the contract has been completed and accepted by the Department and all obligations of the Contractor and the Surety arising under the contract and contract bond have been discharged.

(G) Provision Not Exclusive

The provisions shall be in addition to, and not in place of, any other provisions relating to default, breach of contract, and sanctions to be imposed in connection therewith appearing in the contract.

108-10 CONTRACT TIME; INTERMEDIATE CONTRACT TIME

(A) General

The contract time will be as defined in Section 101. No extensions to the completion date will be authorized except as allowed by this article. No modifications in the date of availability will be made for any reason whatsoever.

Intermediate contract time, as defined in Section 101 will be that as allowed in the contract to complete a part, portion, or phase of the total work covered in the contract. Intermediate completion dates and intermediate completion times set forth in the contract may be extended on the same basis as completion dates and as described in this article.

When the liquidated damages stipulated in the contract are to be on an hourly basis, extensions as described in this article will be considered on an hourly basis.

(B) Completion Date, Intermediate Completion Date, and Intermediate Completion Time Extensions

No extension of the completion date, intermediate completion date, or intermediate completion time will be allowed for any reason except as provided for below:

(1) If the total dollar value of the final quantities adjusted as provided below, less the dollar value of quantities represented by supplemental agreements which previously extended the completion date, intermediate completion date, or intermediate completion time, exceeds the dollar value of the total amount bid, the completion date, intermediate completion date, or intermediate completion time will be extended by the number of calendar days or hours obtained by multiplying the contract time (days), intermediate contract time (days), or intermediate contract time (hours) as set forth in the contract by that percentage that such reduced final dollar value exceeds the total amount bid. The total dollar value of the final quantities for pro-rata computations shall be adjusted by excluding the following:

(a) Unit bid price changes caused by price adjustments to asphalt cement.

(b) Fuel adjustments.

(c) Unit price reductions under the requirements of Article 105-3.

(d) Payment for trainees.

(e) Unit price changes due to pay factors established by the Specifications.

(2) If supplemental agreements covering the performance of extra work include provisions for an extension of the completion date, intermediate completion date, or intermediate completion time, and the final dollar value of the extra work exceeds the estimated dollar value, the number of days or the number of hours by which the completion date, intermediate completion date, or intermediate completion time was extended will be increased by the percentage which the final dollar value exceeds the estimated value.

(3) If the Contractor's current controlling operation(s) are delayed by circumstances originating from work required under the contract and beyond his control and without his fault or negligence, he may, at any time prior to payment of the final estimate, make a written request to the Engineer for an extension of the completion date, intermediate completion date, or intermediate completion time. This request shall include:

(a) the circumstances resulting in the alleged delay and documentation of said circumstances as may be required by the Engineer,

(b) the controlling operation(s) alleged to have been delayed,

(c) the calendar dates or calendar dates and times on which the controlling operation(s) were delayed and

(d) the number of calendar days or hours by which he is requesting the completion date, intermediate completion date, or intermediate completion time to be extended.

If the Engineer determines that the controlling operation(s) were delayed because of circumstances beyond the control of and without the fault or

negligence of the Contractor, and that the Contractor has pursued the work in accordance with Article 108-1, he will extend the completion date, intermediate completion date, or intermediate completion time unless otherwise precluded by other provisions of the contract. No extension of the completion date, intermediate completion date, or intermediate completion time will be allowed for delays caused by restrictions, limitations or provisions contained in the contract.

Consideration will be given for an extension in the completion date, intermediate completion date, or intermediate completion time involving an intermediate contract time of more than 96 hours if the Contractor's current controlling operation(s) is delayed in excess of 40 percent of the total contract time (days), as defined in Section 101, excluding the time between December 15 and March 16; the total intermediate contract time (days), as defined in Section 101, excluding the time between December 15 and March 16; or the total intermediate contract time (hours), as defined in Section 101; due to weather or conditions resulting from weather. No other consideration will be given for extensions in the completion date, intermediate completion date, or intermediate completion time due to delays caused by weather.

Where the intermediate contract time is 96 hours or less, no consideration whatsoever will be given for an extension in the intermediate completion time due to weather or conditions resulting from weather.

(4) If changes in the work from that originally contemplated in the contract are ordered by the Engineer and these changes result in reduction in quantities, elimination of items, additional work and/or extra work, the Engineer will allow an extension in the completion date, intermediate completion date, or intermediate completion time as he may deem warranted by such changes. Pursuit of the work with adequate forces and equipment and efficiency of the Contractor's operations will be considered by the Engineer in determining an extension in the completion date, intermediate completion date, or intermediate completion time. It is, however, the Contractor's responsibility to show just cause for an extension in the completion date, intermediate completion date, or intermediate completion time due to the aforesaid conditions.

(5) In the event accumulated authorized extensions in the completion date or intermediate completion date resulting from 1. through 4. above extend the completion date or intermediate completion date beyond December 15 following expiration of the completion date or intermediate completion date as established in the contract, the completion date will be further extended by the number of calendar days between December 15 of one year and March 16 of the following year. If any portion of such accumulated authorized extensions are for delays which occurred after the original contract time or intermediate contract time (days) expired and during the period between December 15 of one year and March 16 of the following year, this portion of the extension will be deducted from the number of additional calendar days awarded due to extension of the completion date or intermediate completion date beyond December 15.

The Contractor's plea that insufficient contract time (days), intermediate contract time (days), or intermediate contract time (hours) was specified in the contract will not be considered as a valid reason for an extension in the completion date, intermediate completion date, or intermediate completion time.

When all work on the project is totally complete, with the exception of an item or items on which work is precluded by seasonal limitations set forth in the contract, the Engineer may, provided that the Contractor has diligently pursued the work with adequate forces and equipment, waive the assessment of liquidated damages during the period of time from the date all work other than that precluded by seasonal limitations was completed until the date of expiration of the seasonal limitations. The Contractor shall make the request to waive the assessment of liquidated damages in writing prior to the beginning date of the requested waiver. The non-assessment of liquidated damages during the aforesaid period shall not operate to waive any other liquidated damages that may be assessable, or any other terms of the contract.

108-11 LIQUIDATED DAMAGES

Time is an essential element of the contract, and that delay in completing the work will result in damages due to public inconvenience, obstruction to traffic, interference with business, and the increasing of engineering, inspection, and administrative costs to the Department. It is therefore agreed that in view of the difficulty of making a precise determination of such damages, a sum of money in the amount stipulated in the contract, will be charged against the Contractor for each calendar day, each hour, or portion thereof that the work, or any portion of the work as described in the contract, remains uncompleted after the expiration of the completion date, intermediate completion date, or intermediate completion time shown in the contract, not as a penalty but as liquidated damages.

Should the Contractor or, in case of default, the Surety fail to complete the work or any portion of the work by any of the applicable completion dates, intermediate completion dates, or intermediate completion times shown in the contract, a deduction of the amount stipulated in the contract as liquidated damages will be made for each and every calendar day, for each and every hour, or portion thereof that the work or any portion of the work remains uncompleted after the expiration of any completion date, intermediate completion date, or intermediate completion time applicable to the uncompleted work. This amount will be deducted from any money due the Contractor or his Surety under the contract, and the Contractor and his Surety will be liable for any liquidated damages in excess of the amount due.

In the event that the contract establishes one or more intermediate completion dates and/or one or more intermediate completion times in addition to the completion date, each of the liquidated damages stipulated will be considered to be cumulative to any other liquidated damages stipulated.

In case of default of the contract and the completion of the work by the Department, the Contractor and his Surety will be liable for the liquidated damages under the contract, but no liquidated damages will be chargeable for any delay in the final completion of the work by the Department due to any action, negligence, omission, or delay of the Department.

In any suit for the collection of or involving the assessment of liquidated damages, the reasonableness of the amount stipulated in the contract will be presumed. The liquidated

damages referred to herein are intended to be and are cumulative, and will be in addition to every other remedy now or hereafter enforceable at law, in equity, by statute, or under the contract.

Permitting the Contractor to continue and finish the work or any part thereof after the expiration of the completion date, intermediate completion date, or intermediate completion time shall in no way operate as a waiver on the part of the Department of any of its rights under this contract.

108-12 EXTENSION OF CONTRACT TIME AND APPORTIONMENT OF LIQUIDATED DAMAGES

In accordance with Articles 108-10 and 108-11, when a contract is not completed by the completion date, intermediate completion date, or intermediate completion time, the Contractor shall be entitled to an extension of the completion date, intermediate completion date, or intermediate completion time and apportionment and remittance of liquidated damages to the extent that the failure to complete was due to the conditions set forth in Article 108-10. The Contractor, however, shall be entitled to an extension of the completion date, intermediate completion date, or intermediate completion time, or an apportionment and remittance of liquidated damages only to the extent and in the proportion that such delays were caused by the conditions set forth in Article 108-10, and it is understood that any extension granted shall not operate to waive any liquidated damages or any claim which the Department has or may have against the Contractor by reason of failure of the Contractor to complete the said contract by the completion date, intermediate completion date, or intermediate completion time specified therein or as revised by authorized extensions.

108-13 TERMINATION OF CONTRACT

The Board may terminate the contract in accordance with the following provisions:

(A) Consideration will be given to termination of the contract if any of the following circumstances exist:

(1) If it is impossible for the Contractor to obtain critical materials for completion of the contract within a practical time limit, or

(2) If it is impossible for the Contractor to complete the work in accordance with the contract by reason of unanticipated conditions at the site, including slides and unstable subsoil, without a major change in the design of the project and the Contractor will be unduly delayed in completing the project by reason of such unanticipated conditions and changes in design, or

(3) If the Contractor is prevented from proceeding with the contract as a direct result of an Executive Order of the President with respect to the prosecution of war or in the interest of national defense, or

(4) If the Contractor is prevented from proceeding with the work required by the contract as a direct result of a restraining order, or other court order, or by reason of a permit requirement, and the Contractor will be unduly delayed in completing the project by reason of such order or requirement, or

(5) If the Contractor is prevented from proceeding with the work due to the unavailability of the site.

(B) The Contractor shall determine when the circumstances in item (A) exist and are beyond his control, and shall notify the Department in writing of his determination and include adequate documentation of these circumstances along with such notification.

(C) The Contract will be terminated under this article if:

(1) Request by Contractor

(a) The Board concurs in the determination by the Contractor of the circumstances or makes an independent determination that such circumstances herein above indicated exist, and

(b) The Board determines that such circumstances are beyond the control of the Contractor, and the Contractor was not at fault in creating the circumstances, and

(c) The Board determines that a termination of the contract is in the best public interest, or

(2) Authority of the Board:

The Board determines that a termination of the contract is in the best public interest.

(D) The Contractor will be notified in writing by the State Highway Administrator of the action of the Board.

(E) After a contract is terminated in accordance with this termination provision, the following provisions shall be applicable:

(1) When the contract is terminated before completion of all items of work in the contract, payment will be made for the actual number of acceptably completed items of work or acceptably completed portions thereof at the contract unit or lump sum prices. When the contract is terminated before completion of all items of work in the contract and items of work are partially completed or not begun, payment will be made in accordance with Article 104-6.

(2) Payment for costs incurred in organization of the work will be based on verified actual costs and will be included in the adjusted contract lump sum price for Mobilization in accordance with Article 108-13(E)(1). The Contractor shall demonstrate through submission of appropriate documentation that these costs were included in the bid item of Mobilization. After reviewing the submitted cost records and the submitted documentation, the Engineer will make such adjustments as he deems warranted.

(3) Upon request from the Contractor, materials meeting the requirements of the contract that were to have been incorporated into the work or were to remain the property of the Department but are not used in the work will be paid for in accordance with Article 109-6.

(4) No claim for loss of anticipated profits will be considered and no payment will be made for loss of anticipated profits.

(5) Termination of a contract shall not relieve the Contractor of his responsibilities for any completed portion of the work nor shall it relieve his Surety, of its obligation for and concerning any just claims arising out of the work performed.

108-14 TERMINATION OF CONTRACTOR'S RESPONSIBILITY

After the project has been completed and accepted, as provided for in Article 105-17, the Contractor's responsibility will cease except as provided in Article 107-21 and as set forth in his contract bonds. The Contractor shall remain responsible for any amounts determined to be owed the Department in the processing of the final estimate and such amounts shall be paid by the Contractor upon notification by the Department prior to processing of the final estimate.

SECTION 109
MEASUREMENT AND PAYMENT

109-1 MEASUREMENT OF QUANTITIES

All work completed under the contract will be measured by the Engineer according to United States standard measures unless otherwise stated in the contract.

The method of measurement and computations used in the determination of quantities of material furnished and of work performed under the contract will be those methods generally recognized as conforming to accepted engineering practice.

The terms *gauge* and *thickness*, when used in connection with the measurement of plates, sheets, and steel wire, shall be applied as follows:

Uncoated Steel Sheets and Light Plates	United States Standard Gage
Galvanized Sheets	AASHTO M218 or M167
Aluminum Sheets	AASHTO M196 or M197
Steel Wire	AASHTO M32

The term ton will mean short ton (mass) consisting of 2,000 pounds.

Cement will be measured by the barrel unless otherwise indicated elsewhere in the contract. The term *barrel* will mean 376 pounds of cement.

Trucks used to haul material being paid for by weight will be either weighed empty prior to each loading or weighed empty on a daily basis. When trucks are weighed empty on a daily basis, each truck shall be weighed prior to hauling its first load of the day and shall bear a legible identification mark.

Where aggregates that are to be paid for by weight have been stockpiled after being produced, measurement for purposes of payment will be made after the aggregates have been loaded on trucks for direct delivery to the project.

When a complete structure or structural unit, as may be indicated by the unit, *lump sum* or *each*, is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

When standard manufactured items are specified, and these items are identified by gage, unit weight, section dimensions, and/or other dimensions, such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.

109-2 SCOPE OF PAYMENT

The Contractor shall receive and accept payment provided for in the contract as full payment for furnishing all materials and performing all work under the contract in a complete and acceptable manner and for all risk, loss, damage, or expense of whatever character arising out of the nature of the work or the prosecution thereof, subject to the requirements of Article 107-21. Payment to the Contractor will be made only for the actual quantities of the various items that are completed and accepted in accordance with the terms of the contract.

If the *Measurement and Payment* clause in the specifications relating to any unit price or lump sum price in the bid schedule requires that the said unit price or lump sum price cover and be considered compensation for certain work or material essential to the item, this same work or material will not also be measured or paid for under any other pay item that may appear elsewhere in the contract.

109-3 FORCE ACCOUNT WORK

All force account work shall be performed as directed by the Engineer including the numbers and types of equipment, the numbers and classifications of labor and foremen, and material requirements.

All work to be paid for on a force account basis shall be paid for in the following manner:

(A) **Labor** For all authorized labor and foremen in direct charge of the specific operations, the Contractor will receive the rate of base (actual) wages (or scale) actually being paid by the contractor for each hour that the labor and foremen are actually engaged in the specific force account work.

In addition to reimbursement for each hour that the labor and foremen are actually engaged in the specific force account work, the Contractor may receive compensation for travel time to and from the project if and only if the labor and foremen needed are outside a 75 mile radius as included in Subarticle 109-3(B). The base location will be established and approved by the Engineer prior to performing the specific force account work. If the approved labor and foremen travel to another project upon completion of the specific force account work, payment for travel time may not exceed the travel time that would have been required to return to the point of origin in accordance with Subarticle 109-3(B). When travel time is approved by the Engineer, it shall be included in the total hours approved and worked for that specific week. The Engineer will approve the mode of travel.

Prior to beginning the specific force account work, the Contractor will submit in writing for the Engineer's approval a list of all wage rates applicable to the work. Approval will not be granted where these wage rates are not actually representative

of wages being paid elsewhere on the project for comparable classes of labor performing similar work.

Payment for overtime will be allowed when approved by the Engineer prior to performing the specific force account work. Overtime for labor and foremen will be paid based on the company's policy for overtime payment. Verification of such payment will be tracked by submission of weekly payrolls as required on federal projects and as requested on all other projects. Failure to submit payrolls as required or requested shall act as a bar to the Contractor for payment of overtime for labor and foremen. If the labor or foremen is employed partly on specific force account work and partly on other work, the amount of overtime to be reimbursed will be prorated based upon the number of hours worked on the specific force account work during the payroll period.

An additive amount equal to the Contractor's actual labor burden rate, up to a maximum of 60 percent, will be paid to the Contractor for all base (actual) wages paid to labor and foremen for the specific force account work. No additive will be provided for overtime payments. The labor burden rate(s) will include costs associated with the employee's actual base wages benefits, including FICA, unemployment contributions, Social Security and Medicare taxes and company fringe benefits. Company fringe benefits are the actual costs paid to, or on behalf of, workers by reason of health and welfare benefits, pension fund benefits, or other benefits, when such amounts are required by prevailing wage laws generally applicable to the classes of labor employed on the work. The Contractor's actual labor burden rate(s) will be submitted to and approved by the Engineer prior to beginning the work. When the Contractor cannot verify actual labor burden rate(s), an amount equal to 35% percent of the total base (actual) wage paid for labor and foremen will be added to the total base wages paid to the Contractor. These percentage additives will be full compensation for overhead, benefits, contingencies, and all other costs associated with labor for the specific force account work.

(B) Subsistence and Travel Allowances The Contractor may receive payment for actual costs paid to, or on behalf of, labor and foremen by reason of subsistence and travel allowances under certain circumstances. When the Contractor is required to mobilize a crew for specific operations, the Engineer may approve reimbursement of subsistence, including meals and overnight lodging, if the specific force account work is determined to be outside of the scope of the original contract and the distance from the Contractor's base location to the project is more than 75 miles. Should the Contractor utilize forces currently working at the location of the specific force account work, the Engineer may approve the payment of subsistence, including meals and overnight lodging, if the work is determined to be outside of the scope of the original contract, the forces currently working at the location has routinely stayed overnight during the life of the project, and the distance from the Contractor's base location to the project is more than 75 miles. The Engineer will approve the mode of travel.

Payment will be made to the Contractor for subsistence, including meals and overnight lodging, paid in accordance with the Contractor's usual policy for

authorized labor and foremen in direct charge of the specific operations. Subsistence will be limited to the lesser of actual amount paid or the current maximum in-state rate for State employees. Verification of such costs paid to, or on behalf of, labor and foremen will be submitted to the Engineer. If the labor or foremen are partly employed on specific force account work and partly on other work, the amount of subsistence to be reimbursed will be prorated based upon the number of hours worked on the specific force account work during the payroll period.

(C) Materials For materials authorized and accepted by the Engineer and used, the Contractor will receive the actual cost of such materials, including sales tax and transportation charges paid by him (exclusive of equipment rentals as hereinafter set forth), to which costs 15% will be added. The Contractor will furnish records to the Engineer to verify the quantities of materials used in the specific force account work, prices of the materials, sales tax, and costs of transportation for the materials.

If materials used in the specific force account work are not specifically purchased for such work but are taken from the Contractor's stock, the Contractor will furnish an affidavit certifying that such materials were taken from his stock, the quantity was actually used in the specific force account work, and the price and transportation cost claimed represent the actual cost to the Contractor.

(D) Equipment For all equipment authorized by the Engineer to be used on the specific force account work the Contractor will receive rental payment.

Hourly rental rates paid for equipment in use, which is Contractor owned or rented from another Contractor, will not exceed 1/176th of the monthly rate listed in the *Rental Rate Blue Book for Construction Equipment* that is current at the time the specific force account work is performed.

In determining the hourly rate, the regional adjustment factor and the rate adjustment factor for equipment age, as set forth in the current Blue Book, will both be applied to the basic rate. An additive payment equal to 100% percent of the Blue Book estimated operating cost per hour will also be paid for all hours that equipment is in use. This additive payment will be full compensation for fuel, lubricants, repairs, servicing (greasing, fueling, and oiling), small tools, and other incidentals.

If rental rates for the equipment actually being used in the work are not listed in the Blue Book, the Contractor will receive the prevailing rental rates being paid for such equipment in the area where the project is located. An additive payment equal to 15 percent of the prevailing rental rate will also be paid for all hours equipment is in use. This additive payment will be full compensation for fuel, lubricants, repairs, servicing (greasing, fueling, and oiling), small tools, and other incidentals.

Hourly rental rates for equipment held in ready as directed by the Engineer will be 50 percent of the rate paid for equipment in use. An additive payment will not be made for equipment held in ready. When equipment is in use less than 40 hours for any given week and is held in ready as directed by the Engineer, payment for held in ready time will be allowed for up to 40 hours, less hours in use. When payment is made for equipment held in ready as directed by the Engineer, the payment for held in ready time will be allowed for up to 8 hours in a day less hours in use.

Hourly rental rates for idle equipment that is held in ready in accordance with Article 104-4 will be paid at 50 percent of the rate paid for equipment in use. Hourly rental rates for idle equipment held in ready in accordance with Article 104-4 that is rented from a commercial rental agency will be paid for in accordance with the invoice rate for the equipment. An additive payment will not be made for idle equipment. When equipment is in use less than 40 hours for any given week and is held in ready as idle equipment in accordance with Article 104-4, payment for idle equipment time will be allowed for up to 40 hours, less hours in use. When payment is made for idle equipment held in ready in accordance with Article 104-4, the payment for idle equipment time held in ready will be allowed for up to 8 hours in a day less hours in use.

In the event the Contractor does not possess or have readily available such equipment necessary for the performance of the work and such equipment is rented from a commercial rental agency, the Contractor will receive payment based on the approved invoice rate for the equipment.

An additive payment equal to 15 percent of the calculated hourly invoice rate will also be paid for all hours equipment is in use. This additive payment will be full compensation for fuel, lubricants, repairs, servicing (greasing, fueling and oiling), small tools, and other incidentals. The commercial rental agency cannot be the Contractor or an affiliate of the Contractor.

No compensation will be made for the use of equipment not authorized by the Engineer.

The Contractor will be reimbursed for the actual transportation costs for equipment which the Contractor is directed to furnish. Such payment will be limited to transportation costs from the nearest source of available equipment. If equipment is not returned to the point of origin, but is transported to another location, transportation costs will not exceed the cost of return to the point of origin. Rental for such equipment will not be paid when the equipment is being transported. The Contractor will furnish records to the Engineer to verify the actual transportation costs for equipment.

The Contractor will provide to the Engineer for approval a listing of all equipment and attachments to be utilized in the prosecution of the work. The list will include the manufacturer's name, type, model, serial number, and year of manufacture. The list will also include the invoice rate for equipment rented from a commercial rental agency. It will be the Contractor's responsibility to verify the age of the equipment in a manner acceptable to the Engineer. Where such verification is not available, the rate adjustment factor used will be for the oldest equipment listed in the Blue Book.

The above prices and payments will be full compensation for fuel, lubricants, cutting edges, all repairs, and all other operating and maintenance costs other than operator's wages.

(E) Owner-Operated Equipment For all owner-operated equipment authorized by the Engineer to be used on the specific force account work, the Contractor will receive rental payment equal to the existing contract rate(s) with no additive as provided in Subarticles 109-3(A), 109-3(B), 109-3(D) and 109-3(H). When existing contract

rate(s) have not been established, the contractor will submit the proposed rate(s) for the owner-operated equipment with sufficient documentation as deemed necessary by the engineer for approval.

For fully maintained and operated trucks used for the specific force account work, the contractor will receive rental payment equal to the existing contract rate(s) with no additive as provided in Subarticles 109-3(A), 109-3(B), 109-3(D) and 109-3(H). When existing contract rate(s) have not been established, the prevailing industry rate(s) for fully maintained and operated trucks will be used for the specific force account work with approval of the Engineer.

For the purposes of force account work, owner-operated equipment, including fully maintained and operated trucks, will be considered subcontractors. No additional additives other than those allowed under Subarticle 109-3(G) will be allowed.

(F) **Miscellaneous** No additional allowance will be made for general superintendence, the use of manually powered tools, or other costs for which no specific allowance is herein provided.

(G) **Subcontracting** For administrative costs of the Contractor in connection with approved subcontract work at any level and the use of owner-operated equipment at any level, the Contractor will receive an additive amount in accordance with the rate schedule shown below of the total cost of such subcontracted work. The total cost of such subcontracted work will include applicable labor and additive, bond and insurance, materials, and equipment costs incurred by the subcontractor; overhead and profit computed in accordance with Subarticles 109-3(A) through 109-3(D), 109-3(F), 109-3(H) and 109-3(I); and costs for owner-operated equipment, including fully maintained and operated trucks in accordance Subarticle 109-3(E). No additional additives will be allowed.

Total Cost of Subcontract Work	Rate Schedule
$0 - $10,000	10%
Above $10,000	$1,000 + 5% Above $10,000

(H) **Overhead and Profit** An additive payment equal to 10 percent of the specific force account total will be paid to the Contractor. This specific force account total is exclusive of the portion of the work included with Subarticles 109-3(C) Materials, 109-3(E) Owner-Operated Equipment and 109-3(G) Subcontracting. This payment will be full compensation for all costs including but not limited to home office and field overhead, burdens, and profit associated with the specific force account work.

An additive payment equal to 10 percent of the specific force account total for approved subcontract work will also be paid to the subcontractor for overhead and profit. This specific force account total for subcontract work is exclusive of the portion of the work included with Subarticles 109-3(C) Materials and 109-3(E) Owner-Operated Equipment. This payment will be full compensation for all costs including but not limited to home office and field overhead, burdens, and profit associated with the specific force account subcontracted work. No additional additives will be allowed.

(I) **Bond and Insurance** For property damage and liability insurance premiums and bond premiums on the specific force account work the Contractor will receive the

actual cost. The Contractor will furnish satisfactory evidence to the Engineer of the rate or rates paid for such insurance and bond.

An annualized composite percentage may be used to determine the cost for bond and insurance. Insurance costs will be limited to the direct costs associated with the specific force account work. The Contractor will furnish satisfactory evidence to the Engineer of the annualized composite percentage for the bond and insurance.

(J) General The Engineer will maintain the payment records of work performed on a force account basis. The Contractor will compare records of work with the Engineer at the end of each day on which such work is in progress.

Any contention the Contractor may have for an extension in the completion date, intermediate completion date, or intermediate completion time, due to performance of specific force account work will be considered as provided in Article 108-10.

109-4 PARTIAL PAYMENTS

(A) General

Partial payments will be based upon progress estimates prepared by the Engineer at least once each month on the date established by the Engineer. Partial payments may be made twice each month if in the judgment of the Engineer the amount of work performed is sufficient to warrant such payment. No partial payment will be made when the total value of work performed since the last partial payment, excluding mobilization, amounts to less than $10,000.00. Partial payments will be approximate only and will be subject to correction in the final estimate and payment.

Where lump sum items are included in the contract and the applicable section of the Specifications require that fixed percentages of the total amount bid included in partial pay estimates, the Engineer will determine amounts due on partial pay estimate in accordance with the applicable sections of the Specifications.

(B) Prompt Payments

Contractors at all levels, prime, subcontractor, or second tier contractor shall within seven calendar days of receipt of monies, resulting from the satisfactory completion of work performed, pay subcontractors, second tier subcontractors, or material suppliers. This seven-day period begins upon knowledgeable receipt by the contracting firm obligated to make a subsequent periodic or final payment. This prompt payment requirement will be met if each firm mails the payment to the next level firm by evidence of postmark within the seven-day period. For the purposes of this section, the satisfactory completion of work performed shall exist when a subcontractor, second tier subcontractor or material supplier completes tasks called for in the subcontract and are in conformance with the terms of the Contract as required by the Department. This specification for prompt payment shall be incorporated into each subcontract or second tier subcontract issued for work performed on the project or for services provided.

The Contractor shall not withhold any payments to a subcontractor, second tier subcontractor or material supplier for any claim or action arising outside the current

contract with the Department. Notwithstanding the provisions of this section, the Contractor may withhold up to 3% retainage if any subcontractor does not obtain a payment and performance bond for their portion of the work. If any retainage is held on subcontractors, all retainage shall be released within seven calendar days of satisfactory completion of all work. For the purpose of release of retainage, satisfactory completion is defined as completion of all physical elements and corresponding documentation as defined in the contract, as well as agreement between the parties as to the final quantities for all work performed in the subcontract. The Department will provide internal controls to expedite the determination and processing of the final quantities for the satisfactorily completed subcontract portions of the project.

Failure of any entity to make prompt payment as defined herein may result in the Department (1) withholding money from the Contractor due for work performed by that entity in the next partial payment until the necessary assurances are made consistent with this specification; or (2) removing an approved contractor from the prequalified bidders' list or the removal of other entities from the approved subcontractors' list.

(C) Unbalanced Bids

Any excess monies included in an unbalanced bid price that the Department determines to be in excess of a reasonable unit or lump sum bid price for the work, shall be retained by the Department until the last partial payment estimate, at which time these funds will be paid to the Contractor. These retained funds will not be eligible for deposit in any trust account established pursuant to this contract nor for interest for such delay in the payment for the retained portion of the bid price. Partial payment for work performed on an unbalanced bid item shall be at the reasonable unit or lump sum price determined in accordance with this subarticle.

For purposes of this subarticle, a reasonable unit or lump sum price will be deemed to be the average of the Engineer's Estimate and the individual balanced bid prices received from the other bidders for the item in question.

109-5 PAYMENT FOR MATERIAL TO BE USED IN THE WORK.

(A) Material Delivered on the Project

When so authorized by the Engineer, partial payments will be made up to 95 percent of the delivered cost of materials on hand that are to be incorporated in the work, provided that such materials have been delivered on or in close proximity to the project and stored in an acceptable manner. Material payments will be allowed when 95 percent of the accumulated costs of unpaid invoices are equal to or greater than $10,000.00, materials have been inspected and approved by the Engineer, and the documents listed in Subarticle 109-5(C) have been furnished to the Engineer.

(B) Material Stored at Fabricator's Facilities or Contractor's Facilities

When so authorized by the Engineer, partial payments will be made up to 95 percent of the invoiced cost, exclusive of delivery cost, for bulky materials requiring fabrication at an off site location that are durable in nature and represent a significant

portion of the project cost, if it has been determined by the Engineer, that the material cannot be reasonably stockpiled in the vicinity of the work. Material payments will be allowed when the materials have been inspected and approved by the Engineer and the documents listed in Subarticle 109-5(C) have been furnished to the Engineer.

(C) Required Documents

(1) Written consent of surety to make such partial payments,

(2) Bill of Sale from the Contractor to the Department,

(3) Copy of invoice from material supplier verifying the cost of the material.

(D) General Requirements

The partial payments will be made on the conditional basis that the material meets the requirements of the contract and will be incorporated into the project. The Contractor shall reimburse the Department for all partial payments for material paid for, but not incorporated into the project.

Partial payments for materials on hand will not constitute acceptance, and any faulty material will be rejected even though previous payment may have been made for same in the estimates.

Partial payment will not be made for fuel, supplies, form lumber, falsework, or used materials.

Partial payments will not be made on seed or any living or perishable plant materials except that when such materials have been planted or otherwise incorporated in the work, payment may be made, not as materials, but as work done as part of a contract item for which a contract unit or lump sum price has been established.

Partial payments will not exceed 95 percent of the contract unit or lump sum prices for the work.

109-6 PAYMENT FOR LEFTOVER MATERIALS

Payment will be made to the Contractor for materials meeting the requirements of the contract which were to have been permanently incorporated into the work or were to remain the property of the Department but due to revisions or elimination of items of work by the Engineer, due to discrepancies in the contract, or due to termination of the contract are not used in the work. The Contractor upon request will be reimbursed for the verified actual cost of such material delivered to a site designated by the Engineer, including any handling charges less any discount, but in no event shall payment exceed that which would have been made at the contract unit or lump sum price for the completed work.

The Contractor shall furnish invoices and cost records to the Engineer to verify the actual cost of materials, handling charges, discounts that were taken, and transportation charges. No percentage additive will be added to the verified cost of such material.

No payment will be made for loss of anticipated profits and no other payment will be made for leftover materials except as listed above.

109-7 COMPENSATION PAID AT CONTRACT PRICES

Except as provided for by this article, payment for work performed will be made at the contract unit price or the contract lump sum price. Payment shall be made at the adjusted contract unit price, as applicable, when a price adjustment or pay factor is provided for by the contract or as determined by the Engineer in accordance with Article 105-3. In addition to the compensation made at the unit or lump sum price, adjustment in compensation will be made in accordance with Article 109-8. The Contractor shall not be paid for any work performed for which there is not a contract price, nor shall the Contractor receive additional compensation over and above the contract price for work performed or for extra work performed, except for work performed pursuant to an executed supplemental agreement or work performed in accordance with the applicable requirements of Section 104.

109-8 FUEL PRICE ADJUSTMENTS

Fuel price adjustments will be made to the payments due the Contractor for contract items specified in the contract, or for extra work item specified in the supplemental agreement, when the average terminal price has fluctuated from the Base Index Price contained in the contract. The average terminal price is the average of the F.O.B. price for diesel fuel at the terminals in Charlotte, Wilmington and Selma, North Carolina. When the average terminal price fluctuates upward or downward from the Base Index Price, an amount will be added to or deducted from the monies due the Contractor as follows.

The current quantity for the specified contract items for which partial payment is made will be multiplied by the respective Diesel Fuel Usage Factor contained in the contract to determine the theoretical diesel fuel usage for each specified contract item. The sum of the theoretical diesel fuel usage for all specified contract items will be multiplied by the algebraic difference between the average F.O.B. price for diesel fuel at the above specified terminals and the Base Index Price contained in the contract to determine the fuel price adjustment to be made on the partial payment estimate.

The following formula will be used to calculate the appropriate payment or credit on the estimate.

$$S = (A - B)(\Sigma QF)$$

Where:

S = Fuel Price Adjustment for partial payment
B = Base Index Price
A = Average terminal price
Q = Partial payment quantity for contract item
F = Fuel factor for contract item

The average terminal price in effect on the first day of the month in which the partial payment period ends will be used to make payment adjustments for fuel whether or not more than one price fluctuation has occurred within a single partial payment period.

The Engineer's estimate of quantities for contract items measured by cross sections shall be utilized on the various partial payment estimates to determine fuel price adjustments. When the Engineer determines after payment for all or a portion of such contract item that is

subject to a fuel price adjustment that the total quantity of work paid to date will be adjusted to reflect more accurate quantity determinations, the Engineer will make a pro rata increase or decrease in the fuel price adjustment proportionate to the adjustment in the total quantity of work paid. The prorated fuel price adjustment for the contract item will be determined by multiplying the cumulative fuel price adjustment made for that contract item for the previous estimate period(s) by the adjusted quantity for that contract item and divided by the total quantity of work paid for the previous estimates for the contract item. Payment for the prorated fuel price adjustment will be made accordingly on the partial payment estimate that includes the adjustment in the quantity of work paid.

109-9 FINAL PAYMENT

Upon completion of the final estimate assembly, the Engineer will notify the Contractor giving the final quantities and the apparent liquidated damages, if any are assessed. After the Contractor reviews the final quantities and submits the documents listed in Article 109-10, the entire sum found to be due after deducting all previous payments and all amounts to be retained or deducted under the requirements of the contract will be paid the Contractor.

109-10 DOCUMENTS REQUIRED FOR THE PROCESSING OF THE FINAL ESTIMATE

Prior to the processing of the final estimate, the following documents shall have been submitted to and accepted by the Engineer.

(A) Statement of Consent of Surety on the contract bonds for payment of money due the Contractor.

(B) Affidavit of the Contractor that all obligations and debts arising out of the construction have been satisfied, or affidavit which shall include a list of obligations not satisfied.

(C) Written notice that the Contractor has no request for any extension in the completion date or any adjustment in compensation from that shown in the final estimate or in lieu thereof written notice presenting all request for adjustment of the final estimate setting forth full justification for such requests.

(D) Any other documents that are required by the contract such as completed Form FHWA-47 and all reports, statements, and other information necessary for compliance with applicable labor regulations of the Federal Highway Administration.

Submission of false information in the documents required by this section shall be a basis for disqualifying the Contractor from further bidding in accordance with Article 102-16.

109-11 INTEREST ON FINAL PAYMENT

Should final payment on a project not be made within 120 calendar days after the project final acceptance date, interest, at the average rate earned by the State Treasurer on the investment within the State's Short Term Investment Fund during the month preceding the date interest becomes payable, will be paid the Contractor on the final payment for the period beginning on the 121st day after final acceptance and extending to the date the final estimate is paid, provided that the documents required by Article 109-10 have been

submitted within 30 days of the mailing of the notification outlined in Article 109-9. In the event the Contractor fails to submit the required documents within the stipulated 30 day period, and the final estimate is not paid until 120 calendar days following final acceptance of the project, the number of days on which interest accrues will be reduced by the number of days in excess of 30 that the Contractor requires to submit the document(s).

SECTION 150

MAINTENANCE OF TRAFFIC

150-1 GENERAL

The Contractor will be required to maintain traffic within the limits of the project, including all existing roadways that cross or intersect the project, unless otherwise provided in the contract or approved by the Engineer. Traffic shall be maintained from the time the Contractor begins work on the project site until acceptance of the project, including any periods during which the Contractor's operations are suspended, unless otherwise provided for in the contract or approved by the Engineer. The Contractor shall conduct his work in a safe manner that will create a minimum amount of inconvenience to traffic.

The Contractor shall be responsible for maintaining in a safe, passable, and convenient condition, such part or parts of existing roads as are being used by him to maintain traffic within the limits of the project from the time the Contractor begins work on the project until acceptance of the project. As an exception to the above, the Department will be responsible for the removal of ice and snow from all portions of the project open to traffic.

Whenever it is necessary to use traffic control devices as shown in the contract, as determined by the Engineer, or in order to conform to the requirements of this section, the work of furnishing, erecting, operating, maintaining, covering, relocating, and removing traffic control devices shall be in accordance with the requirements of Division 11 & 12.

DIVISION 2
EARTHWORK

SECTION 200
CLEARING AND GRUBBING

200-1 DESCRIPTION

Perform the work of clearing and grubbing in all wooded areas between the construction limits. Perform the work of clearing and grubbing in all non-wooded areas between the construction limits and the limits of the project right of way or in easements shown on the project plans where seeding and mulching, sprigging, sodding, or other work indicated in the plans is to be performed.

(A) **Clearing** is defined as the cutting, removal, and satisfactory disposal of all wooded vegetation and debris.

(B) **Grubbing** is defined as the complete removal and satisfactory disposal of all grassy vegetative matter, root mat, ball and root, topsoil material high in organic content, and surface debris.

Perform the following as part of the work of clearing and grubbing:

(1) Remove and dispose of crops, weeds, and other annual growth.

(2) Remove and dispose of surface debris such as fences, steps, walls, chimneys, column footings, other footings, foundation slabs, basements, other foundation components, signs, junked vehicles, and other rubble and debris.

(3) Fill holes and depressions.

(4) Cut off and plug at the right of way or construction limits any private water or sewer line intercepted during the construction of the project.

(5) Cut off and remove from the right of way or construction area any septic tank or portion thereof encountered within the right of way or construction area during the construction of the project.

(6) Remove materials in wetland areas to a depth of 1’ below existing ground to be measured in accordance with Section 225.

Perform clearing and grubbing operations sufficiently in advance of grading operations to prevent any debris from interfering with the excavation or embankment operations.

In environmentally sensitive areas shown on the original plans, or permit drawings, perform grubbing operations no more than 7 calendar days prior to beginning continuous grading operations.

Perform all work under this section in a manner that will cause a minimum of soil erosion and will meet the requirements of Article 107-13. Coordinate the work with other operations such that no more than 17 acres of exposed, erodible surface area will be accumulated at any one given time by the clearing and grubbing operation until erosion control measures are provided, unless otherwise increased or decreased by the Engineer. Install temporary or permanent erosion control measures as soon as clearing and grubbing or

land disturbing activities begin. Perform such erosion control work, temporary or permanent, as may be necessary to satisfactorily minimize erosion resulting from clearing and grubbing operations.

The Contractor may request an increase in the number of accumulated acres exposed by clearing and grubbing. If approved, establish and maintain such erosion control measures as may be necessary. No payment will be made for the temporary seeding and mulching required by the increase in accumulated exposed acres.

Failure on the part of the Contractor to perform the required erosion control measures will be just cause for the Engineer to direct the suspension of clearing and grubbing operations in accordance with Article 108-7. The suspension will be in effect until such time as the Contractor has satisfactorily performed the required erosion control work. In the event the Contractor fails to perform the directed work within a reasonable length of time, the Engineer may have the work performed in accordance with Article 105-16.

200-2 MATERIALS

Refer to Division 10.

200-3 CLEARING

Perform clearing within the limits established by the clearing method required by the plans and as directed.

The Engineer will designate all areas of growth or individual trees that shall be preserved due to their desirability for landscape or erosion control purposes. When the trees to be preserved are located within the construction limits, they will be so shown on the plans or designated by the Engineer.

Trim or cut branches of trees that overhang the roadbed or obstruct sight distances and that are less than 16 feet above the elevation of the finished grade in a manner that will not endanger the health of the tree.

In embankment areas where the depth of the embankment measured under the roadbed exceeds 6 feet in height, cut sound trees at a height of not more than 6 inches above natural ground. When trees are to be cut outside the construction limits and the Engineer has designated that the area is not to be grubbed, cut the trees reasonably close to the natural ground surface. Cut trees to approximately 6 inches above low water level in swamp areas.

Prevent limb, bark, or root injuries to trees, shrubs, or other types of vegetation that are to remain growing and also prevent damage to adjacent property. Repair scarred areas in accordance with generally accepted horticultural practice. Where plants are damaged by any construction operations to such an extent as to destroy their value for shade or other landscape purposes, cut and dispose of them without extra compensation.

200-4 GRUBBING

Perform grubbing on all areas cleared, with the following exceptions:

(A) In embankment areas, when the depth of embankment measured under the roadbed exceeds 6 feet in height, cut off sound stumps not more than 6 inches above the

existing ground level and do not grub. Remove unsound or decayed stumps to a depth of approximately 2 feet below the natural ground surface.

(B) When authorized, leave stumps in place that are outside of construction limits. Cut such stumps off reasonably close to the natural ground surface.

(C) Cut off stumps in swamp areas to approximately 6 inches above low water level and do not grub.

(D) Do not grub in areas where waste or unsuitable material is to be deposited unless such areas are to become a part of a future roadway.

(E) Grub all areas where piles are to be driven regardless of fill height.

(F) Fill all holes and other depressions within the areas between the construction limits and the limits of clearing and grubbing. Bring all areas to a uniform contour where later mowing operations will take place.

200-5 DISPOSITION OF TIMBER, STUMPS, AND DEBRIS

The property owner will have no right to use or reserve for their use any timber on the project. All timber cut during the clearing operations shall become the property of the Contractor, and shall be removed from the project or shall be satisfactorily disposed of as provided hereinafter.

Do not cut any trees and vegetation beyond the clearing limits established. Do not cut any trees and vegetation that is to be preserved for landscape or erosion control purposes as shown on the plans and permit drawings.

Remove from the project and properly dispose of all vegetation, roots, stumps, tree laps, limbs, and timber remaining on the project by a satisfactory method.

When vegetation is disposed of by burning, burn in such a manner as to prevent injury to property within or outside of the right of way. Comply with all local, State, and Federal laws, ordinances, and regulations when burning. Secure all necessary burning permits. Perform all burning under the constant care of a competent watchman. Do not allow smoldering or dense smoke to occur during burning.

Before trees and/or vegetation are disposed of in locations off the right of way and out of sight of the project, furnish the Engineer with verification that the site is permitted. If required, file an approved reclamation plan and furnish a written release from the property owner, or his authorized agent, granting the servitude of his lands.

If it is not burned, dispose of all debris including vegetation in accordance with Section 802.

200-6 SELECT TREE REMOVAL

When the contract includes the item of *Select Tree Removal* and the work of clearing and grubbing has been completed to the original clearing limits, the Engineer may elect to have select trees removed from the project. Trees removed in this manner shall have an average cross section diameter of at least 4 inches at a point 2 feet above the ground level.

Completely remove the select trees including the root ball and properly backfill unless otherwise directed.

200-7 MEASUREMENT AND PAYMENT

Clearing and grubbing – lump sum will be paid on a lump-sum basis and no measurement will be made of any clearing and grubbing performed within the limits originally staked and within the right of way or easements shown on the original plans.

Supplementary clearing and grubbing that is directed by the Engineer shall be performed on areas outside the limits originally staked or beyond the limits of the right of way or easements or within environmentally sensitive areas shown on the original plans and will be measured and paid for at the contract unit price per acre. All measurement of clearing and grubbing will be made horizontally.

Once the rootmat is removed, material that consists predominately of soils will be measured and paid in accordance with Section 225.

Materials used to fill depressions in accordance with Subarticle 200-4(F) will be measured and paid for in accordance with Section 225, or Section 230, depending on the source of the material.

When the Contractor is required to furnish borrow sources, material sources, or waste areas, or when the Engineer permits the Contractor to obtain borrow or deposit waste on any area within the right of way in lieu of borrow and waste areas which were to have been furnished by the Contractor, no measurement of clearing and grubbing will be made for such areas.

Select tree removal will be measured and paid for as the actual number of select trees satisfactorily removed from the project.

Work performed in cleaning up non-wooded areas between the construction limits and the limits of the project right of way or easements shown on the plans, work performed in the dressing up of areas between the construction limits and the clearing limits, and the removal of weeds, vines, plant stalks, loose rock, and small scattered trees, will be considered as a minor and incidental part of the work of clearing and grubbing.

Payment will be made under:

Pay Item	**Pay Unit**
Clearing and Grubbing	Lump Sum
Supplementary Clearing and Grubbing	Acre
Select Tree Removal	Each

SECTION 205
SEALING ABANDONED WELLS

205-1 DESCRIPTION

Seal abandoned wells at locations shown in the contract or as directed. Perform all work in accordance with the current requirements of the North Carolina Department of Environment and Natural Resources.

205-2 CONSTRUCTION METHODS

Abandonment shall be performed by a certified well contractor.

Seal each well prior to clearing and grubbing the well site.

Check the well from land surface to the entire depth of the well before it is sealed to ensure freedom from obstructions that may interfere with sealing operations.

Prior to sealing, place chlorine in the well in sufficient quantities to produce a chlorine residual of at least 100 milligrams per liter in the well.

All casing and screen materials may be salvaged except casing that is cemented in place. In the case of gravel-packed wells in which the casing and screens have not been removed, perforate the casing opposite the gravel pack at intervals not exceeding 10 feet.

Completely fill *bored wells* with cement grout or dry clay compacted in place.

Completely fill wells constructed in unconsolidated formations with cement grout by introducing it through a pipe extending to the bottom and raising it as the well is filled.

Fill wells constructed in consolidated rock formations or that penetrate zones of consolidated rock to at least 5 feet below the top of the consolidated rock with sand, gravel, or grout opposite the zones of consolidated rock. Fill the remainder of the well with cement grout.

Complete a certified well abandonment record (Form GW 30) and submit to the Engineer.

205-3 MEASUREMENT AND PAYMENT

Sealing abandoned wells will be measured and paid for in units of each for the actual number of wells that have been acceptably sealed. Work includes but is not limited to chlorinating the well prior to sealing, perforating the well casing, filling the well with cement grout, dry clay, sand, or gravel and furnishing all necessary records.

Payment will be made under:

Pay Item	Pay Unit
Sealing Abandoned Wells	Each

SECTION 210

DEMOLITION OF BUILDINGS AND APPURTENANCES

210-1 DESCRIPTION

Demolish, remove, and dispose of all buildings, building components, and appurtenances indicated in the contract.

Do not remove any building or portion of a building intact for any use or purpose.

All material resulting from the demolition work becomes the property of the Contractor. Dispose of or use all materials resulting from the demolition work, except materials that are the property of utility companies providing service to the building. Provide all permits and dispose of all contaminated material encountered in connection with the work.

210-2 GENERAL REQUIREMENTS

Comply with all Federal, State, and local asbestos regulations.

Demolish and clear from the right of way all buildings, including sheds, outbuildings, or other obstructions indicated in the contract. All shelters, porches, roofed areas, and other appurtenances that are attached to the building are considered a part of the building. Steps, chimneys, column footings, other footings, foundation slabs, basements, or other foundation components shall be removed as part of the work of clearing and grubbing.

Do not disturb any fencing, outbuilding, or other obstruction that are entirely clear of the right of way unless otherwise indicated on the plans or in the contract.

Conform to all applicable safety codes pertaining to the work, and secure all permits that may be required, and pay all fees in connection therewith.

210-3 UTILITIES

Make all necessary arrangements with utility companies for the disconnecting of all services and the removal of and recovery by them of all meters, telephones, and any other utility facilities or equipment owned by them. Arrange for and actually effect the disconnecting and closing of water and sewer connections to buildings, including but not limited to any work that shall be done in addition to that normally done by the utility company, in conformity with all applicable codes and regulations of the local Boards of Health. Pay for all costs incurred in connection with the above work. All refunds or deposits that may become due as a result of the disconnection of service and the returning of equipment or facilities to any utility company become the property of the Department.

210-4 DISPOSAL

Unless otherwise indicated in the contract, all materials recovered during demolition become the property of the Contractor to remove from the project. Disposal by burning is permitted, subject to all other applicable sections of these Specifications and all State or local ordinances.

Dispose of materials and debris out of sight of the project as required by Section 802.

210-5 MEASUREMENT AND PAYMENT

There will be no direct payment for demolishing the buildings listed in the contract. Payment for this work will be included in the contract lump sum price for *Clearing and Grubbing*.

As an exception to the above, when the description of the work covered by a particular building demolition item does not contain information concerning the presence of asbestos material and asbestos material is discovered after the opening of bids for the project, the Engineer may have the work performed by others, or the cost of removal and disposal of such asbestos material will be paid for in accordance with the requirements of Article 104-7.

SECTION 215
REMOVAL OF EXISTING BUILDINGS

215-1 DESCRIPTION

Remove and dispose of all buildings, building components, and appurtenances indicated in the contract.

Buildings may be removed intact, removed in sections, or demolished. Dispose of resulting material and debris. All materials resulting from the removal of buildings, except such materials as may be the property of utility companies providing service to the building, become the property of the Contractor to dispose of or use, or sell by him as his own property.

Provide all permits and dispose of all contaminated material encountered in connection with the work.

215-2 GENERAL REQUIREMENTS

Comply with all Federal, State, and local asbestos regulations.

Completely clear from the right of way all buildings, including sheds, outbuildings, or other obstructions as indicated in the contract. Remove all shelters, porches, roofed areas, and other appurtenances, that are attached to the building. Steps, chimneys, column footings, other footings, foundation slabs, basements, or other foundation components shall be removed as part of the work of clearing and grubbing.

Do not disturb any fencing, outbuildings, or other obstruction, that is entirely clear of the right of way unless otherwise indicated on the plans or in the contract.

Conform to all applicable safety codes pertaining to the work, and secure all permits that may be required and pay all fees in connection therewith.

215-3 UTILITIES

Make all necessary arrangements with utility companies for the disconnecting of service and the removal of and recovery by them of all meters, telephones, or any other utility facilities or equipment owned by them. Arrange for and actually effect the disconnecting and closing of water and sewer connections to the buildings, including but not limited to any work that shall be done in addition to that normally done by the utility company, in conformity with all applicable codes and regulations of the local Boards of Health. Pay for all costs incurred in connection with the above work. All refunds or deposits that may become due as a result of the disconnection of service and the returning of equipment or facilities to any utility company becomes the property of the Department.

215-4 DISPOSAL

Unless otherwise indicated in the contract, all materials recovered during demolition become the property of the Contractor to remove from the project. Disposal by burning is permitted, subject to all other applicable sections of these Specifications and all State or local ordinances.

Dispose of materials and debris out of sight of the project as required by Section 802.

215-5 MEASUREMENT AND PAYMENT

There will be no direct payment for removing the buildings listed in the contract. Payment for this work will be included in the contract lump sum price for *Clearing and Grubbing*.

As an exception to the above, when the description of the work covered by a particular building removal item does not contain information concerning the presence of asbestos material and asbestos material is discovered after the opening of bids, the Engineer may have the work performed by others, or the cost of removal and disposal of such asbestos material will be paid for in accordance with the requirements of Article 104-7.

SECTION 225
ROADWAY EXCAVATION

225-1 DESCRIPTION

(A) General

Excavate, place, and compact or satisfactorily dispose of all materials encountered within the limits of the work necessary for the construction of the roadway that are not to be removed under another contract item.

Perform all excavation in conformity with the lines, grades, and cross sections shown on the plans or established by the Engineer.

Use care not to cause instability or displacement of the underlying or adjacent materials during construction. The Engineer reserves the right to effect the removal from the grading operation of any equipment that is causing instability or

displacement of underlying or adjacent materials to the detriment of the section being constructed.

(B) Unclassified Excavation

All material excavated under this section, regardless of its nature or composition, is considered Unclassified Excavation, except for the following:

(1) Undercut Excavation, as provided in Subarticle 225-1(C).

(2) Material directed to be removed beyond the limits of the original slope stakes.

(C) Undercut Excavation

Undercut Excavation consists of the excavation, placement, and compaction and/or satisfactory disposal of materials removed from a location below the finished grade roadway cross section, except for the following:

(1) Rock in the bottom of roadway cuts that has been excavated 1 foot or less below the roadbed and ditches.

(2) In cut areas, excavation removed below the outside slopes of roadway ditches.

225-2 EROSION CONTROL REQUIREMENTS

Install erosion control measures as required by the plans prior to any kind of land-disturbing activity.

(A) Unless otherwise required by the plans, conduct operations in such a manner that cut and fill slopes are completely graded to final slopes in a continuous operation, and permanently seeded and mulched in accordance with the requirements of Article 107 - 13.

(B) Should the Contractor fail to comply with the requirements specified in (A) above within the time frames established by the Sedimentation and Pollution Control Act, the Contractor shall perform temporary seeding and mulching on any exposed areas at his own expense.

(C) When the Contractor fails or neglects to coordinate grading with the permanent seeding and mulching operation, the Engineer may suspend the Contractor's grading operation in accordance with the requirements of Article 108-7 until the work is coordinated in a manner acceptable to the Engineer. Failure to perform the directed work may result in the Engineer having the work performed in accordance with Article 105-16.

225-3 UNCLASSIFIED EXCAVATION

Use all suitable material removed from the excavation as far as practicable in the formation of embankments, subgrades, and shoulders and at such other places as may be indicated on the plans or directed.

The wasting of suitable material removed as part of unclassified excavation prior to the completion of embankments is permitted where the Contractor executes a supplemental agreement documenting that he agrees to the following:

(A) Provide and incorporate into the project any material required to complete the project up to the volume wasted. Bear all additional costs for providing and incorporating this material into the work, including engineering costs, and

(B) Provide suitable replacement material either wasted from the project or approved borrow material, at the Contractor's option, and

(C) Present no claim for any time arising from the wasting of excess unclassified excavation or for having to replace material wasted from the project that the Department may require to complete the work, and

(D) Waive rights to request additional compensation with regard to wasting unclassified excavation under the compensation requirements of Section 104 as a result of wasting suitable unclassified excavation and providing replacement material required to complete the work except when unclassified excavation is a major contract item, as defined in Section 101, and when unclassified excavation underruns by more than 25%.

Where the work required to complete the project is so phased by the plans to preclude utilizing suitable unclassified excavation, the Contractor will be permitted to waste suitable unclassified excavation without having to execute the above required supplemental agreement.

Furnish disposal areas for the unsuitable material except where the Engineer permits or directs the use of such material in the widening or flattening of fill slopes. The Engineer will designate materials that are unsuitable.

Where suitable materials containing excessive moisture are encountered above grade in cuts, construct above grade ditch drains prior to the excavation of the cut material when such measures are necessary to provide proper drainage.

Upon execution of a supplemental agreement containing conditions listed below, the Contractor may waste suitable unclassified excavation and replace it with approved borrow material.

(A) Replace with approved borrow material all suitable unclassified excavation that was wasted.

(B) Bear all additional costs associated with the wasting of the unsuitable unclassified excavation and the replacing of it with borrow material, including any additional engineering costs to the Department.

(C) The execution of a supplemental agreement allowing the Contractor to waste suitable unclassified excavation and replace it with approved borrow material bars the Contractor from any claim for any time extensions related to the wasting and replacement operation described in the agreement.

(D) The Contractor specifically waives his rights to request additional compensation with regard to wasting unclassified excavation under the compensation requirements of

Section 104 as result of substituting suitable borrow material and wasting suitable unclassified excavation.

Where the contract includes earth shoulder construction, stockpile suitable surplus material for use in the shoulders. To the extent possible, salvage topsoil from within the limits of the slope stake lines and store in stockpiles. Before the topsoil is removed, clear the areas of all weeds, brush, stumps, stones and other debris. Remove the topsoil from only such areas and to only such depths as required by the contract or as directed. Exercise care to avoid mixing subsoil or other unsuitable material with the topsoil. Stockpile an adequate quantity of material to construct the proposed shoulder before wasting any suitable surplus material. Locate the stockpiles along the project at approved locations. Neatly dress each stockpile, when completed. Perform temporary or permanent seeding on the stockpiles where directed or when necessary to prevent erosion. Remove and dispose of any surplus material remaining in the stockpile after the shoulders are completed as provided below for waste matter.

Dispose of waste material in accordance with Section 802.

Uniformly round the intersection of slopes with natural ground surfaces, including the beginning and ending of cut slopes, as shown on the plans. Concurrent with the excavation of cuts, construct intercepting berm ditches or earth berms along and on top of the cut slopes at locations shown on the plans or as designated. Finish all slopes to reasonably uniform surfaces acceptable for seeding and mulching operations. Leave no rock or boulders in place that protrude more than 1 foot within the typical section cut slope lines. Clean all rock cuts of loose and overhanging material. Remove all protruding roots and other objectionable vegetation from the slopes.

Where a cut has been finished and the slopes dressed in accordance with the plans and slope stakes, the Contractor will not be required to flatten or widen the slopes of a completed cut unless otherwise directed prior to beginning the work. When rock is unexpectedly encountered, transition any widening or flattening already begun to leave the cut with a pleasing appearance.

If required, investigate the top 12 inches of the subgrade in cut sections to determine the necessity for rock undercut. This investigative work will be paid for in accordance with Article 104-7.

Unless otherwise directed, excavate rock in the bottom of roadway cuts to a depth of 1 foot below the roadbed and ditches. Lower ditches if necessary so that water will drain from the rock surface to the ditches. Upon completion of the rock excavation below the level of the roadbed and ditches, backfill the areas where such rock has been removed with suitable material, compact, and shape to the required grade and cross section.

Prior to any work beginning on the structure, excavate all rock under and adjacent to structure sites as directed.

Bring all cuts to the grade and cross section shown on the plans, prior to final inspection and acceptance.

Remove and dispose of slides and overbreaks that occur prior to final acceptance of the project. Where slides and overbreaks occur due to negligence or carelessness on the part of the Contractor, the removal and disposal of said slides and overbreaks will be at no cost to the Department.

All excavation done in the shaping of old roadways to produce a pleasing appearance in accordance with the requirements of Section 808 is paid for as Unclassified Excavation.

Conduct earthwork operations in a manner that will not disturb staking, utility poles or guy wires required to remain in their original location.

Cut off and plug all private utility lines, remove existing shoulder drain and subdrain pipe and remove all underground tanks intercepted within the typical section or in conflict with construction.

Where it is necessary to remove existing sidewalks or driveways, furnish a neat edge along the pavement retained by sawing a neat line approximately 2 inches deep with a concrete saw before breaking the adjacent pavement away.

When excavation operations encounter graves, temporarily discontinue operations in the vicinity of the graves and do not resume until directed.

When excavation operations encounter contaminated soils, temporarily discontinue operations in the vicinity of the contamination and do not resume until directed.

When excavation operations encounter artifacts of historical or archeological significance, temporarily discontinue operations in the vicinity of the artifacts and do not resume until directed. Disposition of the artifacts shall be in accordance with the requirements of the Division of Archives and History.

225-4 UNDERCUT EXCAVATION

When the Engineer determines that the natural soil materials in areas where fills are to be placed are undesirable in their location or condition, the Engineer may require the Contractor to remove the undesirable material and backfill with approved, properly compacted material.

When the Engineer determines that the finished graded roadway cross section contains materials that are undesirable in their location or condition, the Engineer may require the Contractor to remove the materials and backfill with approved, properly compacted material to the finished graded section.

Where undercutting is required adjacent to or beneath the location of the proposed drainage structure, perform undercut and backfill a sufficient distance adjacent to the installation to prevent future operations from disturbing the completed drainage structure.

Utilize equipment in undercutting and backfilling operations of such weight, size, and capability to efficiently remove and replace the material within the limits established. Use equipment of a size and weight that will not displace the underlying or adjacent material.

All material removed in the work of undercut excavation will be classified by the Engineer as either suitable for other use without excessive manipulation and utilized elsewhere in the work, or unsuitable for further use and disposed of by the Contractor.

Conduct undercut operations in such a way that the Engineer can take the necessary measurements before any backfill is placed.

Place backfill in undercut areas in a continuous operation concurrent with the undercutting operation. Do not place backfill material in water unless otherwise permitted by the Engineer.

225-5 TOLERANCES

A tolerance of plus or minus 0.10 foot from the established grade will be permitted in the roadbed after it has been graded to a uniform surface.

225-6 MAINTENANCE

Maintain all work covered by this section during construction until final acceptance.

Provide the drainage of surface runoff along and throughout the length of the cut, construct temporary ditches, and use any other methods necessary to control excessive soil erosion during construction and until final acceptance of the project.

225-7 MEASUREMENT AND PAYMENT

Excavation will be measured and paid for in cubic yards of materials, measured in their original position and computed by the average end area method, that have been acceptably excavated in accordance with the contract. The Engineer may also elect to use Digital Terrain Modeling (DTMs) for determining the earthwork quantities, or other new technology that has been proven accurate. Original cross sections for the determination of excavation quantities will be taken before any grading begins. Final cross sections will be taken after the excavation has been completed. Final plan cross sections can be used for the final cross sections where, in the opinion of the Engineer, the work has been constructed in reasonably close conformity to the plan typical section.

Original and final cross sections will be taken by either ground or aerial survey methods, as determined by the Engineer.

All materials excavated from a location below the graded roadway cross section are classified as *Undercut Excavation* and will be measured separately except for the following:

(A) Rock in the bottom of roadway cuts excavated 1 foot or less below the roadbed and ditches.

(B) In cut areas, undercut excavation is limited to excavation removed below the roadbed sub-grade, removed below the inside slopes of roadway ditches, and removed below the bottom of flat bottom roadway ditches.

(C) Rootmat removed as a part of clearing and grubbing.

When the contract does not include item of *Drainage Ditch Excavation,* measurement will be made in accordance with the requirements of Article 240-4 and payment for this class of excavation will be made at the contract unit price per cubic yard for *Unclassified Excavation*.

Measurement of materials excavated from overbreaks or slides will be made except where the overbreaks or slides were due to the negligence or carelessness of the Contractor.

No measurement will be made of any materials excavated outside of authorized excavation limits established by the Engineer, or any materials excavated before slope stakes were set.

Article 104-5 will not be applicable for any underruns in the quantity of Unclassified Excavation resulting from the permitted use of such material as Select Granular material.

Berm Ditch Construction will be measured and paid for in accordance with the requirements of Article 240-4.

Materials excavated from stockpiles and used to construct earth shoulders will be paid for as *Shoulder Borrow* in accordance with the requirements of Article 560-4. No payment will be made for the removal and disposal of any surplus material remaining in the stockpile after the shoulders have been completed.

Payment for material that the Engineer directs to be removed beyond the limits of the original slope stakes will be made in accordance with Article 104-3.

Payment includes but is not limited to excavation, blasting, hauling anywhere along the project both within and across balance points shown on the plans, removal of undesirable material, removal of sidewalk, driveways, curb and gutter, endwalls, traffic islands and drainage structures, disposal of materials, formation and compaction of embankments, subgrades and shoulders, the cutting off, plugging, and removal of private utility lines and underground tanks and any backfilling required, removing any existing shoulder drain or subdrain pipe and maintaining the work.

Payment will be made under:

Pay Item	Pay Unit
Unclassified Excavation	Cubic Yard
Undercut Excavation	Cubic Yard

SECTION 226
COMPREHENSIVE GRADING

226-1 DESCRIPTION

The work covered by this section consists of all elements of work covered by Section 200 Clearing and Grubbing, Section 225 Roadway Excavation, Section 230 Borrow Excavation, Section 235 Embankments, Section 250 Removal of Existing Pavement, Section 500 Fine Grading Subgrade, Shoulders, and Ditches, and Section 560 Shoulder Construction, except that the requirements of the above-referenced sections pertaining to measurement and payment will not apply unless specific reference is made to such Specifications.

226-2 CONSTRUCTION METHODS

Perform the work in accordance with the requirements of Sections 200, 225, 230, 235, 250, 500, and 560.

226-3 MEASUREMENT AND PAYMENT

Seeding and mulching all borrow sources will be measured and paid for at the contract unit prices for such items established in the contract.

Payment for material that the Engineer directs the Contractor to obtain from borrow sources to backfill pipe culverts, box culverts, drainage structures, or structure bents will be made in accordance with Article 104-7.

Payment for material that the Engineer directs to be removed beyond the limits of the original slope stakes will be made in accordance with Article 104-3.

Grading will be paid for at the contract lump sum price. Partial payments will be equal to the percentage of such item that is complete as estimated by the Engineer. No separate payment will be made for clearing and grubbing or draining borrow sources as such work will be considered incidental to the work covered by this section.

Clearing and grubbing work that in directed to be performed on areas outside the limits originally staked or beyond the limits of the right of way or easements shown on the original plans will be measured and paid for at the contract unit price per acre for *Supplementary Clearing and Grubbing*. All measurements will be made horizontally. Where the contract does not include this item, a unit price per acre will be established by supplemental agreement.

Undercut Excavation will be measured and paid for at the contract unit price per cubic yard. No separate payment will be made for materials used in backfilling the undercut areas as payment at the contract unit price per cubic yard for *Undercut Excavation* will be full compensation for furnishing such material. Where the contract does not include a pay item for *Undercut Excavation*, payment for such excavation will be made in accordance with Article 104-7.

Payment will be made under:

Pay Item	Pay Unit
Grading	Lump Sum
Supplementary Clearing and Grubbing	Acre
Undercut Excavation	Cubic Yard

SECTION 230
BORROW EXCAVATION

230-1 DESCRIPTION

Excavate approved material from borrow sources. Haul and utilize such material as required on the plans or as directed Do not use borrow excavation until all available suitable unclassified excavation has been incorporated into the embankments, subgrades, and shoulders except by execution of a supplemental agreement documenting the conditions prescribed below.

(A) All suitable unclassified excavation wasted as a result of the previous utilization of borrow material will be deducted from the total volume of borrow excavation paid under the contract.

(B) Reimburse the Department for all additional costs, including additional engineering cost, associated with the wasting of suitable unclassified excavation.

(C) Any claim for contract time extensions related to the early utilization of borrow is waived should the Contractor use borrow material prior to all suitable unclassified excavation being incorporated into the project pursuant to a supplemental agreement.

(D) Rights to request additional compensation with regard to the early utilization of borrow under the compensation requirements of Section 104 except when unclassified excavation is a major contract item, as defined in Section 101, and that unclassified excavation overruns by more than 25%.

Where the work required to complete the project is so phased by the plans to preclude utilizing suitable unclassified excavation, the Contractor will be permitted to construct the required embankments, subgrades, or shoulders so controlled by the phasing from approved borrow materials without having to execute the above required supplemental agreement.

230-2 COORDINATION WITH SEEDING OPERATIONS

Coordinate the work in this section with the construction of embankments so that the requirements of Article 225-2 are met.

230-3 MATERIALS

Refer to Division 10:

Item	Section
Borrow Material	1018

230-4 CONSTRUCTION METHODS

(A) General

Thoroughly clear and grub and clean the surface of the borrow area of all unsuitable material before beginning the excavation and, where applicable, before cross-sections are taken. Dispose of material resulting from clearing and grubbing in accordance with Article 200-5. Remove and dispose of overburden in accordance with Section 802.

Do not accumulate exposed, erodible slope area in each borrow operation in excess of 1 acre at any one given time without beginning permanent seeding and mulching of the borrow source or installing other erosion control measures as may be approved.

Remove and stockpile topsoil at locations that will not interfere with the borrow operations and that meet the approval of the Engineer. Install temporary erosion control measures as may be necessary to prevent the erosion of the stockpile material. Once all borrow has been removed from the source or portion thereof, uniformly spread the stockpiled topsoil over the area and permanently seed and mulch the area.

Where payment is made by cross section, notify the Engineer sufficiently in advance of beginning excavation of the borrow material so that the area may be staked and cross sectioned. No payment will be made for any material excavated prior to cross sections being taken. Excavate the material to the lines and slopes as staked in an orderly manner to facilitate measurement at any time.

Where payment is to be made by truck measurement, furnish trucks with bodies suitable for accurate measurement. Load trucks uniformly and in such a manner as to prevent spillage.

When necessary to haul borrow material over existing roads or streets, the requirements of Article 105-15 apply. Use all necessary precautions to prevent damage to the existing structures or pavement. Conduct hauling operations in such a manner as to not interfere with the normal flow of traffic and keep the traffic lanes free from spillage at all times.

Furnish borrow sources except where otherwise indicated in the contract.

(B) Contractor Furnished Sources

Prior to the approval of any borrow source(s) developed for use on any project, obtain certification from the State Historic Preservation Officer of the State Department of Cultural Resources certifying that the removal of the borrow material from the borrow source(s) will have no effect on any known district, site building, structure, or object that is included or eligible for inclusion in the National Register of Historic Places. Furnish a copy of this certification to the Engineer prior to performing any work on the proposed borrow source.

Borrow sources will not be allowed in any area under the Corps of Engineers regulatory jurisdiction until the Contractor has obtained a permit for such borrow sources from the Corps District Engineer having jurisdiction and has furnished a copy of this permit to the Engineer. Requests for additional contract time, additional compensation, or for work stoppage due to permit violations will not be considered.

The approval of borrow sources furnished by the Contractor is subject to the following conditions:

(1) Provide written proof of the right to take the material and any rights of access that may be necessary, for locating and developing the source, and any clearing and grubbing and drainage ditches necessary. The proof shall include an agreement with the owner that the borrow source be dressed, shaped, seeded, mulched, and drained as required by these Specifications after all borrow has been removed.

(2) Sampling and testing of contractor furnished borrow material will be in accordance with procedures set forth in *the Procedures for Sampling and Approving Contractor Furnished Borrow Sources* in effect on the date of advertisement for the project. Copies of this document are available from the Materials and Tests Unit. The criteria for acceptance of the proposed contractor furnished borrow material is shown in Section 1018.

(3) Except where borrow is to be obtained from a commercial source, jointly submit with the property owner a borrow source development, use, and reclamation plan to the Engineer for his approval prior to engaging in any land disturbing activity on the proposed source other than material sampling that may be necessary. The Department's borrow and waste site reclamation procedures for contracted projects is available on the NCDOT website and shall be utilized for all borrow and waste sites on this project. Address the following in the plan:

(a) Topography

Detail the existing topography and locations of the proposed access and egress haul roads. Detail the proposed final topography of the waste or disposal area showing any proposed drainage systems. Excavate the source according to the plan and dress and shape it in a continuous manner to contours that are comparable to and blend in with the adjacent topography. Grade the source to drain such that no water will collect or stand. Provide a functioning drainage system for the source. If drainage is not practical, and the source is to serve as a pond, the minimum depth shall be a least 4 feet as determined from the water table at the time the reclamation plan is executed. The slope of the soil below the water shall be between 5:1 and 2:1. The slope of the sides above the water line shall be 2:1 or flatter.

(b) Erosion Control

Detail the temporary and permanent erosion control measures, along with design calculations, that are intended during use of the site and as part of the reclamation. Unless considered impractical due to special circumstances, provide in the plan for the use of staged permanent seeding and mulching and appropriate fertilizer topdressing on a continual basis during site use and the immediate total reclamation of the site when the site is no longer needed. Define the seed mixture proposed for establishing temporary and/or permanent vegetation. Establish permanent stand of vegetation prior to acceptance of the project.

(c) Buffer Zones

Allocate sufficient area between the nearest property line and the tie-in of the slope to natural ground to allow for the operation of excavation, hauling, and seeding equipment and for the installation of any and all erosion control devices required. Leave additional undisturbed area

between the source and any water course or body to prevent siltation of the water course or body and the movement of the shore line either into the water course or body or into the waste areas. Determine if the adjoining property owners or other government agencies require any additional buffer zones and comply with those requirements. Suggested minimum distances are 10 feet from property lines and 50 feet from water bodies or water courses. Where it is necessary to drain the borrow source, perform this work in accordance with Section 240.

(d) Evaluation for Potential Wetlands and Endangered Species

Hire an experienced environmental consultant from the approved list to perform an assessment of the borrow site for potential conflicts with wetlands, Areas of Environmental Concern designated by CAMA, and federally protected species. This evaluation will not be required for permitted commercial sites.

Delineate the boundaries of any wetlands or jurisdictional surface waters (streams) encountered. Follow the standard practice for documenting the wetland delineation including completion of the Army Corps of Engineer's approved *wetland data form*. Document information including data regarding soil, vegetation and hydrology. Maintain a minimum 25 foot buffer adjacent to all sides of the wetland boundary and a minimum 50 foot buffer adjacent to any stream. Depict the limits of the delineated wetland and surrounding buffer on the Reclamation Plan. Do not remove borrow material in any area under the Corps of Engineers' or any other environmental agencies' regulatory jurisdiction unless and until the NCDOT permit has been modified to allow such disposal activity in the jurisdictional area.

Perform a site assessment for federally listed threatened or endangered species to include habitats that may support these species. Provide a detailed technical report on the assessment findings. If federally listed threatened or endangered species or habitat that may support such species exist on the proposed borrow site, notify the Engineer prior to continued pursuit of such site.

(e) Approval

Obtain written approval from the Engineer prior to excavating any material within the proposed borrow source area.

Submit a revised or additional reclamation plan if the non-permitted waste or disposal area is expanded by more than one acre or is significantly changed from the previously approved submittal.

If the Contractor proposes a borrow source, the environmental assessment shall include wetland and stream delineation extending 400 feet beyond the proposed borrow source limits.

(i) If wetlands or streams are present within 400 feet of the borrow source:

Submit a hydrologic analysis (Skaggs Method) or equivalent to determine if lateral effects will permanently impact or cause degradation to wetlands or streams. The analysis shall be performed by an environmental or hydraulics engineer with expertise in this discipline and shall consist of, but not be limited to:

Hydric soil type
Average profile depth to restrictive soil layer
Effective hydraulic conductivity or permeability
Average drainable porosity or available water capacity
Required buffer width, including safety factor

(ii) If wetlands or streams are present within 400 feet and the contractor does not propose to excavate below the seasonal high water table or the water level in the adjacent stream, no documentation will be required.

(iii) If wetlands or streams are not present within 400 feet, no additional documentation will be required

During Department review of the proposed borrow area, the hydrologic analysis will be submitted to the U. S. Army Corps of Engineers for evaluation.

Obtain copy of Skaggs Method for Determining Lateral Effects of a Borrow Pit on Adjacent Wetlands from the Department's website.

(C) Maintenance

During construction and until final acceptance, use any methods approved by the Engineer that are necessary to maintain the work covered by this section so that the work will not contribute to excessive soil erosion.

230-5 MEASUREMENT AND PAYMENT

Borrow Excavation will be measured and paid for in cubic yards. Borrow excavation will be measured in place in its original position except that truck measurement will be made where called for in the contract.

If the quantity of borrow excavation used is excessive as evidenced by the presence of surplus suitable material from the roadway excavation, the measured quantity of borrow excavation will be reduced by the quantity of such surplus suitable material.

In Place Measurement: *Borrow Excavation* to be paid for will be the actual number of cubic yards of approved material, measured in its original position by cross sectioning and computed by the average end area method, that has been excavated from the borrow source and incorporated into the completed and accepted work. No measurement will be made of any overburden or unsuitable material removed from the source, or of any material excavated prior to cross sections being taken.

Truck Measurement: Borrow excavation to be paid for will be the actual number of cubic yards of approved material, measured in trucks, that has been excavated from the borrow source and incorporated into the completed and accepted work. Each truck will be measured and shall have a legible identification mark indicating its capacity. Load each truck to at least its measured capacity at the time it arrives at the point of delivery. The recorded capacity will be adjusted by making a 25 percent deduction to allow for shrinkage, and the adjusted capacity will be the quantity to be paid for.

Topsoil that is stockpiled and placed back on the source as a part of the reclamation effort will be measured in the stockpile by cross sectioning and computed by the average end area method and paid for per cubic yard for *Borrow Excavation*. No in place measurement will be made of the topsoil.

Seeding And Mulching and establishment of temporary erosion control for all borrow sources will be made at the contract unit prices for the items established in the contract as payment for seeding and mulching.

Payment includes but is not limited to: furnishing the source of the borrow; providing and implementing a development, use, and reclamation plan, evaluation of potential wetlands and endangered species, building, maintaining, and obliterating haul roads, clearing and grubbing or draining the borrow source; removing, stockpiling, and replacing topsoil, removing and disposing of overburden and other unsuitable material, excavation, hauling, formation of roadway embankments, subgrades, and shoulders, restoration of the source and haul roads to an acceptable condition, obtaining permits and/or certifications, and maintaining the work.

Payment will be made under:

Pay Item	Pay Unit
Borrow Excavation	Cubic Yard

SECTION 235
EMBANKMENTS

235-1 DESCRIPTION

Place suitable material excavated under Sections 225, 226, 230, and 240 in embankments, backfills, and earth berms, to conform with the lines, grades, and typical cross sections shown on the plans. Fill and compact holes, pits, and other depressions when unsuitable material has been removed. Work includes preparation, formation, compaction, and maintenance of the embankment area as well as the formation of benches in the existing ground with rises less than 60 inches.

235-2 COORDINATION WITH SEEDING OPERATIONS

Coordinate work with excavation operations to meet the requirements of Article 107-13 and Article 225-2.

235-3 MATERIALS

Use soil consisting of loose, friable, sandy material free of subsoil admixtures, refuse, stumps, rocks, roots, root mats, or other unsatisfactory material.

Wet, dry, or frozen material may be suitable when dried, wetted, or thawed, respectively. Waste suitable material only with written authorization.

Use Select Material in accordance with Section 1016 when required by the contract.

235-4 CONSTRUCTION METHODS

(A) Preparation for Embankment

(1) Finish clearing and grubbing within an area before starting embankment in accordance with Section 200.

(2) Remove and waste organic or other unsuitable material unless otherwise directed.

(3) Plow mowed sod and leave in place where the height of embankment to be constructed is greater than six feet measured under the roadbed.

(4) Plow or scarify and break up cleavage planes of all underlying road surfaces.

(5) Remove or break up existing pavement in accordance with Section 250.

(6) Bench existing slopes steeper than 4:1 measured at right angles to the roadway.

(a) Provide rises of not less than 12 inches nor greater than 60 inches as embankment is brought up in layers.

(b) Provide sufficient width for the operation of placing and compaction equipment.

(c) Begin bench cut at the intersection of the original ground and the vertical side of the previous cut.

(d) Construct benches greater than 60 inches in height only when shown on the plans. Such benches will be paid for in accordance with the contract.

(B) Embankment Formation

(1) Uniformly spread material in successive, approximately horizontal layers of not more than 10 inches in depth, loose measurement, for the full width of the cross section.

(2) Compact each layer in accordance with Subarticle 235-4(C).

(3) Shape embankment surface to properly drain at all times.

(4) Route construction equipment uniformly over the full width of the embankment and prevent deep rutting.

(5) May construct the first layer of embankments across saturated or unstable material, that does not support the weight of hauling equipment, by successively dumping a uniformly distributed layer of a thickness not greater than necessary to support hauling equipment while placing subsequent layers.

(6) When placing material in swamp or in water, keep unsuitable surge material in a fluid state or remove to prevent trapping in or under embankment.

(7) When shown on the plans or allowed by the contract, form a satisfactory base by end or side dumping in valleys, ravines, and at the foot of slopes on side hills.

(8) Where embankments are being constructed principally of rock or broken pavement, place in uniform layers with a maximum depth of 36 inches.

Place rock or broken pavement so larger pieces are evenly distributed and are no larger than 36 inches in any dimension.

Fill all voids.

Place rock or broken pavement lifts a minimum of two feet below finished subgrade or finished grade whichever is lower.

(9) Do not place rock or broken pavement greater than two inches in diameter within 12 inches of the subgrade or finished greater whichever is lower.

(10) Do not place rock or broken pavement in areas where foundations are to be placed.

(11) Place Select Material where indicated in the contract.

(12) Construct stabilized embankment when required by the contract.

(13) Install pipe culverts as specified in Section 300.

(14) Construct subsurface drains adjacent to structures as required by Article 414-8 for box culverts and Article 410-9 for other structures, except for that portion of the drain located below the elevation of the original ground.

(15) Do not disturb existing utilities within the project construction limits until released by the Engineer.

(C) Embankment Compaction

(1) Compact each layer for its full width to a density equal to at least 95 percent of that obtained by compacting a sample of the material in accordance AASHTO T99 as modified by the Department. Copies of these modified procedures are available upon request from the Department's Materials and Tests Unit.

(2) Uniformly bond all layers to preceding layers.

(3) Compact all surfaces on embankment slopes, principally constructed of soil, that are flatter than 1 ½:1 using tracked equipment or other approved methods.

(4) Increase or decrease moisture content of the material before compacting to produce the maximum density that will provide a stable grade.

(5) Exempt portions of rock embankments, that cannot be tested by approved methods, from density requirements.

(D) Maintenance

(1) Maintain all embankments made under the contract until final acceptance.

(2) Construct and maintain adequate drainage of surface runoff to prevent soil erosion.

(3) Replace damaged or displaced embankment caused by Contractor carelessness or negligence at no cost to the Department.

(4) Replace damaged or displaced embankment as a result of natural causes. Payment for this repair work will be at the contract unit price for the excavated material required to make the necessary repairs.

(5) Bring all embankments to the grade and cross section shown on the plans prior to final inspection and acceptance.

235-5 TOLERANCES

Finish subgrade surface within plus or minus 0.10 foot from the established grade after it has been graded to a uniform surface.

235-6 MEASUREMENT AND PAYMENT

Payment will not be made for embankment construction. Payment at the contract unit prices for the various items covered by Section 225, 226, 230, and 240 will be full compensation for all work covered by this section.

SECTION 240
DITCH EXCAVATION

240-1 DESCRIPTION

(A) General

Excavate and satisfactorily dispose of all materials excavated in the construction of ditches except silt ditches.

(B) Drainage Ditches

Drainage ditches are defined as inlet and outlet ditches for pipe culverts and structures, changes in channels of streams, ditches draining borrow and material sources, and parallel or lateral ditches when such ditches are separated from the roadway slope by an area of natural ground or berm.

Unless otherwise classified on the plans, parallel or lateral ditches constructed as an integral part of the graded roadbed, having a continuous slope from the outer limit of the shoulder to the bottom of the ditch, will be considered to be within the roadway grading limits and will be part of the work covered by Section 225.

(C) Berm Ditches

Berm ditches are defined as ditches constructed by either excavation or the construction of earth berms along the top of the cut slopes. The location of berm ditches will be as shown on the plans or as directed.

240-2 GENERAL

Excavate to the lines, grades, typical sections, and details shown on the plans or established. Coordinate all work covered by this section with the grading, construction of drainage structures, excavation of borrow and material sources, and other work along the project, and maintain in a satisfactory condition so that adequate drainage is provided at all times. Maintain the ditches until the final acceptance of the project. Trim flush with the sides of the ditch any roots that protrude into the ditch. Complete inlet and outlet ditches for pipelines before the pipe is installed unless otherwise permitted.

240-3 DISPOSAL OF MATERIALS

Utilize all excavated materials in the construction of roadway embankments except where otherwise directed. Deposit materials that are excess to the needs of the project alongside the ditch, and spread to form a low, flat, inconspicuous spoil bank of sufficient regular contour to permit seeding and mowing, provided no drainage into the ditch is blocked.

240-4 MEASUREMENT AND PAYMENT

Drainage Ditch Excavation will be measured and paid for in cubic yards, measured in the original position by the average end area method of all materials excavated within the limits established by the plans or directed. Work includes but is not limited to excavation, shaping of the ditches, disposal of all materials, construction of earth berms, and the maintenance of the work in an acceptable condition until final acceptance.

No measurement and payment will be made where excavation has been performed beyond the above limits; made solely for the convenience of the Contractor; for temporary drainage of the project; or for any excavation to provide drainage of borrow or material sources furnished by the Contractor.

Where the contract does not include a pay item for *drainage ditch excavation*, all work of drainage ditch excavation will be treated as unclassified excavation and will be paid in accordance with Section 225.

Berm Ditch Construction will be measured and paid for in linear feet, measured along the flow line of the ditch within the pay limits shown on the plans, completed and accepted. Work includes but is not limited to excavation, shaping of the ditches, disposal of all materials, construction of earth berms, and the maintenance of the work in an acceptable condition until final acceptance.

Payment will be made under:

Pay Item	Pay Unit
Drainage Ditch Excavation	Cubic Yard
Berm Ditch Construction	Linear Foot

SECTION 250
REMOVAL OF EXISTING PAVEMENT

250-1 DESCRIPTION

Break up, remove and satisfactorily dispose of the portland cement concrete or asphalt components of an existing roadway pavement structure, including paved shoulders, within the limits shown on the plans or as directed. This work includes the removal of any temporary roadway pavement structure placed during construction to serve as a detour.

250-2 PAVEMENT REMOVAL AND DISPOSAL

Break up and remove the pavement for its entire depth. Where concrete or asphalt pavement is to be removed, provide a neat edge along the pavement being retained by sawing the pavement approximately 2 inches deep before breaking the adjacent pavement away. Properly dispose of all materials resulting from the pavement removal as provided herein.

When existing pavement is located where embankment is to be constructed, and the depth of the embankment is greater than 1 foot exclusive of base and pavement, do not remove existing pavement, but break up the existing pavement into pieces with the longest dimension no larger than 3 feet . Fill all voids. All voids must be filled when building an embankment out of rock or broken pavement.

Use all materials in the construction of embankments, unless otherwise directed. Stockpile materials, that the Department desires to use, as indicated on the plans at approved locations.

Where the Contractor requests permission to use salvageable material in other parts of the work and such material has been intended for use in the construction of embankments, the Engineer may permit such use provided the Contractor furnishes at no cost to the Department an adequate quantity of material for embankment construction to replace the material used in all other parts of the work.

Dispose of all materials that cannot be used in the work in accordance with Section 802.

250-3 MEASUREMENT AND PAYMENT

Removal of Existing Asphalt Pavement will be measured and paid for in square yards of existing asphalt pavement actually removed and disposed of properly. Removal of existing asphalt pavement will be measured by actual surface measurement of the asphalt pavement prior to its removal.

Removal of Existing Concrete Pavement will be measured and paid for in square yards of existing concrete pavement actually removed and disposed of properly. Removal of existing concrete pavement will be measured by actual surface measurement of the concrete pavement prior to its removal.

Breaking of Existing Concrete Pavement will be measured and paid for in square yards of existing concrete pavement actually broken up and left in place. The quantity will be determined by actual surface measurement of the pavement prior to breaking it up.

Breaking of Existing Asphalt Pavement will be measured and paid for in square yards of existing asphalt pavement actually broken up and left in place. The quantity will be determined by actual surface measurement of the pavement prior to breaking it up.

Where the pavement removed or broken up is a combination of layers of both asphalt and concrete pavement, payment will be made at the contract unit price per square yard for *Removal of Existing Concrete Pavement* or at the contract unit price for *Breaking of Existing Concrete Pavement*.

Where the pavement removed is a combination of layers of both asphalt and concrete pavement and an item is not established for concrete pavement removal, the cost of removing the combination of layers of asphalt and concrete will be made in accordance with Article 104-7.

Payment includes but is not limited to breaking up, removing and disposing of existing concrete or asphalt pavement, including paved shoulders and removing any temporary roadway pavement structure placed during construction to serve as a detour.

This work does not include removing and disposing of sidewalks, driveways, curb and gutter, traffic islands, and parking areas, or any other incidental paved structures that are not part of a roadway pavement structure.

Payment will be made under:

Pay Item	Pay Unit
Removal of Existing Asphalt Pavement	Square Yard
Removal of Existing Concrete Pavement	Square Yard
Breaking of Existing Concrete Pavement	Square Yard
Breaking of Existing Asphalt Pavement	Square Yard

SECTION 260
PROOF ROLLING

260-1 DESCRIPTION

Furnish and operate at the direction of the Engineer, heavy pneumatic tired compaction equipment for compacting the roadbed and testing the roadbed for stability and uniformity of compaction.

260-2 EQUIPMENT

Provide equipment with the following features:

(A) Four rubber tired wheels mounted on a rigid steel frame.

(B) Wheels evenly spaced in one line across the width of the roller and arranged so that all wheels will carry approximately equal loads when operated over an uneven surface.

(C) Maximum center to center spacing between adjacent wheels is 32 inches.

(D) Load capacity from 48 to 50 tons unless otherwise permitted in writing.

(E) The loaded roller shall be covered or constructed so that it will not trap water that will add weight to the ballast.

(F) Other equipment of equal or better effectiveness may be substituted with written permission.

(G) Tire pressures shall be between 68 and 72 psi unless otherwise permitted in writing. Inflate tires with air only; use no liquid.

Provide ballasts consisting of bulk sand, bulk stone, bags of sand, stone, or other materials of known unit weight such that the total weight of the ballast used can be readily determined at all times. Provide a sufficient amount of ballast to load the equipment to a maximum gross weight of 50 tons.

Use rubber tired or other types of tractive equipment for operation of this equipment on the roadbed. The entire assembly including motivating equipment shall be capable of executing a 180 degree turn on a 27 foot wide area.

260-3 CONSTRUCTION METHODS

After the roadbed has been completed within 0.50 foot of final grade, compact and test the roadbed with 1 foot coverage, unless otherwise directed, with a heavy pneumatic tired roller meeting the requirements of Article 260-2. Coverage is considered that stage in the rolling procedure when the entire width of the area being proof rolled has been in contact with the pneumatic tires of the roller. Operate the roller in a systematic manner so that the number of coverages over all areas to be proof rolled can be readily determined and recorded.

Operate the equipment at a speed between 225 and 300 feet per minute.

Perform proof rolling only in the presence of the Engineer.

Proof roll areas again following the completion of the necessary corrections. Perform proof rolling at no cost to the Department if the corrections are necessary due to the negligence of the Contractor or weather.

Protect all structural facilities on the project, such as but not limited to bridges, box culverts, pipe culverts, and utilities, from damage by the proof rolling equipment. Protection may include unloading and reloading of the roller, detouring, protective earth pads, or other suitable measure to avoid damage.

260-4 MEASUREMENT AND PAYMENT

Proof Rolling will be measured and paid for as the actual number of hours, measured to the nearest 0.1 hour, during which the heavy pneumatic tired roller has been engaged in proof rolling in the presence of the Engineer, exclusive of hours of proof rolling performed following corrective action made necessary by the negligence of the Contractor or by weather.

Corrective work necessary, as determined by proof rolling, and not due to negligence of the Contractor or to weather, will be paid for at the applicable contract unit prices or as extra work, whichever may be applicable.

Payment includes furnishing all labor, equipment, fuel, and ballast for loading, loading and unloading ballast as directed, and increasing and decreasing tire pressure as directed.

Payment will be made under:

Pay Item	Pay Unit
Proof Rolling	Hour

SECTION 265
SELECT GRANULAR MATERIAL

265-1 DESCRIPTION

Furnish and place select granular material over the previously placed fabric for soil stabilization and/or backfill in water as shown in the plans and as directed.

265-2 MATERIALS

Refer to Division 10:

Item	Section
Class II Select Material	1016-3
Class III Select Material	1016-3

265-3 CONSTRUCTION METHODS

Select granular material used over the soil stabilization fabric and/or backfill in water shall be either Class II or Class III Select Material.

Place Select Granular Material 3 feet above the fabric and/or backfill in water.

265-4 MEASUREMENT AND PAYMENT

Select granular material will be measured and paid in cubic yards of select granular material that has been incorporated into the completed and accepted work.

Work includes but is not limited to furnishing, hauling, placing and all incidentals necessary to satisfactorily complete the work. When the Engineer permits select granular material being obtained from either unclassified excavation or from an approved borrow source, payment will be provided for select material under this pay item and not under the pay items contained in Articles 225, 226 or 230.

Payment will be made under:

Pay Item	Pay Unit
Select Granular Material	Cubic Yard

SECTION 270
FABRIC FOR SOIL STABILIZATION

270-1 DESCRIPTION

Furnish and install synthetic fabric for soil stabilization in accordance with the contract or as directed.

270-2 MATERIALS

Refer to Division 10

Item	Section
Fabric for Soil Stabilization, Type 4	1056

270-3 CONSTRUCTION METHODS

Grubbing may not be required in areas where fabric for soil stabilization will be used. Minimize the use of heavy equipment in these areas in order to limit rutting. Cut trees flush with the ground surface and place fabric on relatively undisturbed ground as directed.

Do not leave fabric uncovered for more than 7 days. Provide a surface free of obstructions, debris and soft pockets. Place the fabric at locations as directed. Place the fabric with the long dimension parallel to the centerline of the roadway and lay it smooth and free from tension, stress, folds, wrinkles or creases. Overlap all transverse and longitudinal joints at least 18 inches unless otherwise directed to sew or bond seams together. Use wire staples as needed to hold the fabric in place until it is covered. Unless otherwise stipulated, provide backfill material meeting the requirements of the contract. Do not operate equipment on the fabric until it is covered with material as directed. Do not use vibratory compaction equipment on the initial lift of backfill.

270-4 MEASUREMENT AND PAYMENT

Fabric for Soil Stabilization will be measured and paid for as square yards of fabric, measured along the surface of the ground that has been acceptably placed. No separate measurement will be made for overlapping fabric, sewing seams or bonding. Work includes but is not limited to furnishing, hauling, placing, and sewing the fabric and furnishing and placing wire staples.

Payment will be made under:

Pay Item	Pay Unit
Fabric for Soil Stabilization	Square Yard

DIVISION 3
PIPE CULVERTS

SECTION 300
PIPE INSTALLATION

300-1 DESCRIPTION

Excavate, undercut, provide material, condition foundation, lay pipe, joint and couple pipe sections, and furnish and place all backfill material as necessary to install the various types of pipe culverts and fittings required to complete the project.

Perform the work according to the requirements of the contract for either Method A or Method B pipe installation. Use Method A, except where Method B is called for on the plans.

Do not waste excavation unless permitted. Use suitable excavated material as backfill; or in the formation of embankments, subgrades, and shoulders; or as otherwise directed. Furnish disposal areas for the unsuitable material. The Engineer will identify excavated materials that are unsuitable.

Where traffic is to be maintained, install pipe in sections so that half the width of the roadway is available to traffic.

300-2 MATERIALS

Refer to Division 10:

Item	Section
Select Materials	1016
Joint Materials	1032-9(G)

Provide foundation conditioning material meeting the requirements of Article 1016-3 for Class II or III as shown in the plans and Specifications.

When metal pipe is specified, use fully bituminous coated galvanized pipe in accordance with Subarticle 1032-4(A)(1) in the following counties:

Beaufort, Bertie, Bladen, Brunswick, Camden, Carteret, Chowan, Columbus, Craven, Currituck, Dare, Gates, Hertford, Hyde, Jones, Martin, New Hanover, Onslow, Pamlico, Pasquotank, Pender, Perquimans, Tyrrell, and Washington.

300-3 UNLOADING AND HANDLING

Unload and handle pipe with reasonable care. Do not roll or drag metal pipe or plates over gravel or rock during handling. Take necessary precautions to ensure the method used in lifting or placing the pipe does not induce stress fatigue in the pipe. Use a lifting device that uniformly distributes the weight of the pipe along its axis or circumference. Repair minor damage to pipe when permitted. Remove pipe from the project that is severely damaged or is rejected as being unfit for use. Undamaged portions of a joint or section may be used where partial lengths are required.

300-4 PREPARATION OF PIPE FOUNDATION

Prepare the pipe foundation in accordance with the applicable method shown on the plans, true to line and grade, and uniformly firm.

Camber invert grade an amount sufficient to prevent the development of sag or back slope in the flow line. The Contractor shall determine the amount of camber required and submit to the Engineer for approval.

Loosely place foundation conditioning material, in a uniform layer, to conform with Method A or Method B pipe installation.

Excavate recesses to receive the bells where bell and spigot type pipe is used. Where material is found to be of poor supporting value or of rock and when the Engineer cannot make adjustment in the location of the pipe, undercut existing foundation material within the limits established on the plans. Backfill the undercut with either a suitable local material secured from unclassified excavation or borrow excavation at the nearest accessible location along the project, or foundation conditioning material as specified in the contract.

Maintain the pipe foundation in a dry condition.

300-5 INVERT ELEVATIONS

The proposed pipe culvert invert elevations shown on the Drainage Summary Sheets are based upon information available when the plans were prepared. If proposed invert elevations are adjusted during construction based upon actual conditions encountered, no claim for an extension of time for any reason resulting from this information will be allowed.

When a pipe culvert is to be installed in a trench and the average actual elevation of the pipe between drainage structures deviates from the average proposed elevation shown on the Drainage Summary Sheets by more than one foot a pay adjustment will be made as follows:

$$\text{Pay Adjustment (per linear foot)} = [(\text{APE}-\text{AAE}) \pm 1 \text{ foot}] \, (0.15 \times \text{CUP})$$

Where: CUP = Contract Unit Price of Pipe Culvert

$$\text{AAE} = \text{Average Actual Elevation} \quad \frac{(\text{Actual Inlet elev.} + \text{Actual Outlet elev.})}{2}$$

$$\text{APE} = \text{Average Plan Elevation} \quad \frac{(\text{Plan Inlet elev.} + \text{Plan Outlet elev.})}{2}$$

When the actual location of a pipe culvert is changed from the location shown on the plans, the Engineer will make a pay adjustment deemed warranted based upon the relation of the pipe culvert as shown on the plans to the finished roadway and the relation of the pipe culvert as constructed to the finished roadway.

The top elevation column on the drainage summary sheet indicates the flow elevation at the top of structures intended to collect surface water.

The top elevation column on drainage structures not intended to collect surface water indicates the elevation at the top of the cover.

300-6 LAYING PIPE

(A) Rigid Pipe

Lay pipe on prepared foundation, bell or groove end upgrade with the spigot or tongue fully inserted to make a watertight joint. Check each joint for alignment and grade as the work proceeds.

Use flexible plastic joint material except when material of another type is specified in the plans or special provisions. Joint material of another type may be used when permitted.

(B) Flexible Pipe (Except Structural Plate Pipe)

Place flexible pipe carefully on the prepared foundation starting at the downstream end with the inside circumferential laps pointing downstream and with the longitudinal laps at the side or quarter points.

Handle bituminous coated pipe and paved invert pipe with special care to avoid damage to coatings. Install paved invert pipe with the paved invert centered on the bottom.

Join pipe sections with coupling band, fully bolted and properly sealed with joints made watertight. Provide coupling bands for annular and helical corrugated metal pipe with circumferential and longitudinal strength sufficient to preserve the alignment, prevent separation of the sections, and prevent backfill infiltration. Match-mark all pipe 60 inches or larger in diameter at the plant for proper installation on the project.

At locations indicated in the plans, corrugated steel pipe sections shall be jointed together with rod and lug coupling bands, fully bolted. Sleeve gaskets shall be used in conjunction with rod and lug couplings and the joints properly sealed and made watertight. Coupling bands shall provide circumferential and longitudinal strength sufficient to preserve the alignment, prevent separation of the sections and prevent infiltration of backfill material.

300-7 BACKFILLING

Place fill around the pipe in accordance with the applicable method shown on the plans in layers not to exceed 6 inches loose unless otherwise permitted. Compact to the density required by Subarticle 235-4(C). Approval of the backfill material is required prior to its use. Use select material when called for in the contract.

Take care during backfill and compaction operations to maintain alignment and prevent damage to the joints. Keep backfill free from stones, frozen lumps, chunks of highly plastic clay, or other objectionable material.

Grade and maintain all pipe backfill areas in such a condition that erosion or saturation will not damage the pipe foundation or backfill.

Do not operate heavy equipment over any pipe until it has been properly backfilled with a minimum 3 feet of cover, or the same depth above the top of loose material over pipe for Type-B pipe installation. Place, maintain, and finally remove the required cover that is

above the proposed finished grade at no cost to the Department. Remove and replace, at no cost to the Department, pipe that becomes misaligned, shows excessive settlement, or has been otherwise damaged by the Contractor's operations.

300-8 MAINTENANCE

Maintain all pipe installations in a condition such that they will function continuously from the time the pipe is installed until the project is accepted.

300-9 MEASUREMENT AND PAYMENT

General

No measurement will be made of any work covered by this section except for the work of undercut excavation, foundation conditioning and providing select material that is not local material. Removal and disposal of existing pavement is a part of the excavation for the new pipe culvert installation. Repair of the pavement will be made in accordance with Section 654.

Foundation Conditioning

Using Local Material

Undercut excavation is all excavation removed by undercutting below the bottom of the trench as staked. *Undercut Excavation* will be measured as the actual number of cubic yards of undercut excavation, measured in its original position and computed by the average end area method, that has been removed as called for in the contract and will be paid for at double the contract unit price for *Unclassified Excavation* as provided in Article 225-7.

Local material used for conditioning the foundation will be measured and paid for as provided in Article 225-7 for *Unclassified Excavation* or in Article 230-5 for *Borrow Excavation* depending on the source of the material.

Local material used to replace pipe undercut excavation will be measured and paid for in accordance with Article 225-7 or Article 230-5.

Using Other Than Local Material

No measurement and payment will be made for *Undercut Excavation*. The material used to replace pipe undercut excavation will be classified as foundation conditioning material. *Foundation Conditioning Material, Minor Structures* will be measured and paid for as the actual number of tons of this material weighed in trucks on certified platform scales or other certified weighing devices.

No direct payment will be paid for undercut excavation. Payment at the contract unit price for *Foundation Conditioning Material, Minor Structures* will be full compensation for all work of pipe undercut excavation.

Select Material

Select material is classified as material meeting the requirements of Section 1016, other than local material or borrow material. *Select material* will be measured and paid for as the

actual number of tons of this material weighed in trucks on certified platform scales or other certified weighing devices, that has been used for backfilling above the foundation.

Where local material or borrow material meeting the requirements for select material as specified in Section 1016 is used for backfilling above the foundation, this material will be measured and paid for as provided in Article 225-7 or Article 230-5.

Where other than local material is used for backfilling above the foundation, the quantity of select material, will be measured and paid for at the contract unit price per ton for *Select Material, Class_____,* or where there is no unit price in the contract applicable to the class of select material involved, the select material will be paid for as extra work in accordance with Article 104-7.

Payment at the contract prices for the various items covered by Sections 310, 320, 330, 340 and 350 will be full compensation for all work covered by this section except for foundation conditioning, and select material.

Payment will be made under:

Pay Item	Pay Unit
Foundation Conditioning Material, Minor Structures	Ton
Select Material, Class_____	Ton

SECTION 310
PIPE CULVERTS

310-1 DESCRIPTION

Furnish and install concrete pipe, corrugated aluminum alloy pipe, corrugated steel pipe and pipe arch, bituminous coated corrugated steel pipe, concrete lined corrugated steel pipe, bituminous coated corrugated steel pipe arch, vitrified clay pipe and sections of the class, type, and size called for in the contract. The work includes construction of joints and connections to other pipes, endwalls, and drainage structures.

310-2 MATERIALS

Refer to Division 10:

Item	Section
Plain Concrete Pipe Culvert	1032-9(B)
Reinforced Concrete Pipe Culvert	1032-9(C)
Precast Concrete Pipe End Sections	1032-9(D)
Concrete Pipe Tees and Elbows	1032-9(E)
Corrugated Aluminum Alloy Pipe Culvert	1032-2(A)
Corrugated Aluminum Alloy Pipe Tees and Elbows	1032-2(B)
Corrugated Steel Culvert Pipe and Pipe Arch	1032-3(A)

Prefabricated Corrugated Steel Pipe End Sections	1032-3(B)
Corrugated Steel Pipe Tees and Elbows	1032-3(C)
Corrugated Steel Eccentric Reducers	1032-3(D)
HDPE Smooth Lined Corrugated plastic Pipe	1044-7
Bituminous Coated Corrugated Steel Pipe Culvert	1032-4(A)
Prefabricated Bituminous Coated Corrugated Steel Pipe End Sections	1032-4(B)
Bituminous Coated Corrugated Steel Pipe Tees and Elbows	1032-4(C)
Bituminous Coated Corrugated Steel Eccentric Reducers	1032-4(D)
Concrete Lined Corrugated Steel Culvert Pipe	1032-4(F)
Concrete Lined Corrugated Steel Pipe Tees and Elbows	1032-4(F)
Vitrified Clay Culvert Pipe	1032-7

Suppliers that provide metal pipe culverts, fittings, and all other accessories covered by this section shall meet the requirements of the Department's Brand Certification program for metal pipe culverts , and be listed on the Department's pre-approved list for suppliers of metal pipe culvert.

Do not use plain galvanized or aluminized corrugated steel pipe in the following counties:

Beaufort, Bertie, Bladen, Brunswick, Camden, Carteret, Chowan, Columbus, Craven, Currituck, Dare, Gates, Hertford, Hyde, Jones, Martin, New Hanover, Onslow, Pamlico, Pasquotank, Pender, Perquimans, Tyrell, and Washington.

310-3 PIPE INSTALLATION

Install pipe, pipe tees, and elbows according to Section 300.

310-4 SIDE DRAIN PIPE

Install concrete, corrugated steel, or HDPE smooth lined corrugated plastic side drain pipe in accordance to Section 300.

When using HDPE smooth lined corrugated plastic side drain pipe, provide a minimum earth cover of 12 inches when placing under asphalt or concrete and a minimum earth cover of 18 inches when placing under soil.

310-5 PIPE END SECTIONS

Choose which material to use for the required end sections. Both corrugated steel and concrete pipe end sections will work on concrete pipe, corrugated steel pipe, and HDPE smooth lined corrugated plastic pipe.

310-6 MEASUREMENT AND PAYMENT

Pipe will be measured and paid for as the actual number of linear feet of pipe that has been incorporated into the completed and accepted work.

Measurement of pipe will be made by counting the number of joints used and multiplying by the length of the joint to obtain the number of linear feet of pipe installed and accepted. Measurements of partial joints are made along the longest length of the partial joint to the nearest 0.1 of a foot. *Pipe end sections, tees, elbows, and eccentric reducers* will be measured and paid for as the actual number of each of these items that have been incorporated into the completed and accepted work.

Payment will be made under:

Pay Item	**Pay Unit**
__" R.C. Pipe Culverts, Class ____.	Linear Feet
__" x __" x __" R.C. Pipe Tees, Class____	Each
__" R.C. Pipe Elbows, Class ____.	Each
__" C.A.A. Pipe Culvert, __" Thick	Linear Feet
__" x __" x__" C.A.A. Pipe Tees, __" Thick	Each
__" C.A.A. Pipe Elbows, __" Thick	Each
__" C.S. Pipe Culverts, __" Thick	Linear Feet
__" x __" C.S. Pipe Arch Culverts, __" Thick	Linear Feet
__ x __" x__" C.S. Pipe Tees, __" Thick	Each
__" C.S. Pipe Elbows, __" Thick	Each
__" x __" C.S. Eccentric Reducers, __" Thick	Each
__" Bituminous Coated C.S. Pipe Culverts, Type ___, __" Thick, Type ___, __" Thick	Linear Feet
__" Bituminous Coated C.S. Pipe Culverts, Type ___ , __" Thick, Elongated	Linear Foot
__" x __" Bituminous Coated C.S. Pipe Arch Culverts, Type ____, __" Thick	Linear Foot
__" x __" x __" Bituminous Coated C.S. Pipe Tees, Type ____, __" Thick	Each
__" Bituminous Coated C.S. Pipe Elbows, Type ____, __" Thick	Each
__" x __" Bituminous Coated C.S. Eccentric Reducers, Type ____, __" Thick	Each
__" Side Drain Pipe	Linear Foot
__" Pipe End Section	Each
__" Concrete Lined C. S. Pipe Culverts, __" Thick Steel	Linear Foot
__" x __" x __" Concrete Lined C. S. Pipe Tees, __" Thick Steel	Each

__" Concrete Lined C. S. Pipe Elbows, __" Thick Steel	Each
__" Vitrified Clay Pipe Culverts	Linear Foot

SECTION 320
CORRUGATED STEEL and ALUMINUM ALLOY STRUCTURAL PLATE PIPE AND PIPE ARCH

320-1 DESCRIPTION

Furnish and install corrugated steel and corrugated aluminum alloy structural plate pipe and pipe arch of the size and gage called for on the plans at locations indicated in the contract. The work includes the construction of joints and connections to other pipes, endwalls, and other drainage structures.

320-2 MATERIALS

Refer to Division 10:

Item	Section
Corrugated Structural Plate Pipe and Pipe Arch	1032-5
Corrugated Aluminum Alloy Structural Plate Pipe and Pipe Arch	1032-6

Suppliers that provide metal pipe culverts, fittings, and all other accessories covered by this section shall meet the requirements of the Department's Brand Certification program for metal pipe culverts, and be listed on the Department's pre-approved list for suppliers of metal pipe culvert.

Provide for review, design and detail drawings for all structural plate elbows, wyes, and tees. All designs and details shall meet the requirements of AASHTO Section 12 and be sealed by a North Carolina Licensed Professional Engineer. Provide seven copies of the plans and one copy of the design calculations to the Engineer for review and acceptance prior to beginning fabrication. Include the cost of any required reinforcement (stiffeners, miscellaneous fabricated steel, heavier gage plates, etc.) in the unit bid prices for the items involved.

Provide elbows, wyes, and tees of at least the same gauge as the connecting pipe culvert.

320-3 CONSTRUCTION METHODS

(A) Excavation, Foundation Preparation, and Backfilling

Install the pipe and pipe arch in accordance with Section 300 except place a minimum of 6 inch thickness of foundation conditioning material in accordance with the details shown in the plans.

(B) Erection

Erect in accordance with the manufacturer's assembly diagrams and instruction sheets. All erection procedures and methods shall meet industry standards. Handle structural plate with reasonable care. Do not drag or skid plate. The plate or the

assembled pipe or pipe arch will be rejected, if the spelter coating is broken beyond repair prior to acceptance.

Assemble the entire pipe culvert completely before placing any backfill. Erect elongated pipe with the long diameter in a vertical position. Maintain correct position of pipe during assembly, correct for spiraling.

Install all bolts in accordance with the procedures specified by the manufacturer before backfill is placed. Tighten all nuts to a minimum of 100 foot-pounds and a maximum of 200 foot-pounds of torque. Check nut tightness with a properly calibrated torque wrench before, during, and after placing backfill.

Camber the invert grade by an amount sufficient to prevent the development of sag or back slope in the flow line after the backfill is placed. The Contractor shall determine the amount of camber required and submit to the Engineer for approval.

(C) Workmanship

Provide quality workmanship when installing the pipe and pipe arch. Evidence of poor or inadequate workmanship includes but is not limited to the following:

(1) Uneven laps.
(2) Improper shaping.
(3) Variation from a straight center line.
(4) Ragged edges.
(5) Loose, unevenly lined or spaced bolts.
(6) Illegible identification stamp on any plate.
(7) Bruised, scaled or broken spelter coating.
(8) Dents or bends in the metal itself.

Poor or inadequate workmanship may constitute sufficient cause for rejection of the completed or partially completed work, or of any materials proposed for use in the work.

(D) Elbows, Wyes, and Tees

Shop fabricate all structural plate elbows, wyes, and tees with the angle between the branch and main line of the lateral as noted on the plans. Provide joint connections in accordance with the manufacturer's instructions.

320-4 MEASUREMENTAND PAYMENT

Corrugated Steel Structural Plate Pipe or Pipe Arch will be measured and paid for as the actual number of linear feet of pipe or pipe arch, measured along the flow line of the pipe or pipe arch, not including elbows, wyes, and tees, to the nearest foot, that has been completed and accepted.

Corrugated Steel or Corrugated Aluminum Alloy Structural Steel Plate Elbows, Wyes, and Tees will be measured and paid for as the actual number of these items that have been incorporated into the completed and accepted work.

Payment will be made under:

Pay Item	**Pay Unit**
__" C.S. Structural Plate Pipe, ____Gauge	Linear Foot
__" C.S. Structural Plate Pipe, ____ Gauge, Elongated	Linear Foot
__" x __" C.S. Structural Plate Pipe Arch, ____Gauge	Linear Foot
__" C.A.A. Structural Plate Pipe, __" Thick	Linear Foot
__" C.A.A. Structural Plate Pipe, __" Thick Elongated	Linear Foot
__" x __", C.A.A. Structural Plate Pipe Arch, __" Thick	Linear Foot
__" C.S. Structural Plate Pipe Elbow, Elongated, ___Gauge (__" x __" Corrugation)	Each
__" C.S. Structural Plate Pipe Elbow, Elongated, ____ Gauge, with ____ Bolts, " x __" Corrugation	Each
__" C.S. Structural Plate Pipe Wye, Elongated, ____ Gauge (__" x __" Corrugation)	Each
__" C.S. Structural Plate Pipe Wye, Elongated, ____ Gauge, With ____ Bolts, __" x __" Corrugation	Each
__" C.S. Structural Plate Pipe Tee, Elongated, ____ Gauge __" x __" Corrugation	Each
__" C.S. Structural Plate Pipe Tee, Elongated, ____ Gauge, With ____ Bolts, __" x __" Corrugation	Each
__" C.A.A. Structural Plate Pipe Elbow, Elongated, ____ Gauge __" x __" Corrugation	Each
__" C.A.A. Structural Plate Pipe elbow, Elongated, ____ Gauge, With ____ Bolts, __" x __" Corrugation	Each
__" C.A.A. Structural Plate Pipe Wye, Elongated, ____ Gauge __" x __" Corrugation	Each
__" C.A.A. Structural Plate Pipe Wye, Elongated, ____ Gauge, With ____ Bolts, __" x __" Corrugation	Each
__" C.A.A. Structural Plate Pipe Tee, Elongated, ____ Gauge __" x __" Corrugation	Each
__" C.A.A. Structural Plate Pipe Tee, Elongated, ____ Gauge, With ____ Bolts, __" x __" Corrugation	Each

SECTION 330
WELDED STEEL PIPE

330-1 DESCRIPTION

This work shall consist of furnishing and installing welded steel pipe by trenchless methods as shown in the contract and as directed.

330-2 MATERIALS

Refer to Division 10:

Item	Section
Welded Steel Pipe	1032-8

Suppliers that provide metal pipe culverts, fittings, and all other accessories covered by this section shall meet the requirements of the Department's Brand Certification program for metal pipe culverts and be listed on the Department's pre-approved list for suppliers of metal pipe culvert.

330-3 PIPE INSTALLATION

Install the pipe by trenchless construction, true to line and grade and in a manner such that settlement does not occur. Fill all voids around the pipe. Installations that become damaged or have to be abandoned will be replaced by the Contractor at no cost to the Department as directed by the Engineer.

Conduct a pre-construction meeting in the presence of the Engineer at least 48 hours prior to the beginning of the pipe installation. The meeting shall consist of but not limited to:

(A) reviewing all installation methods to install the pipe true to the line and grade given,
(B) methods to insure there is no settlement of the pipe or of the completed roadway section,
(C) methods for filling any potential voids around the pipe.

330-4 MEASUREMENT AND PAYMENT

___ *" Welded Steel Pipe In Soil* will be measured and paid for as the actual number of linear feet of pipe measured along the flow line to the nearest foot, which has been installed in soil.

___ *" Welded Steel Pipe Not In Soil* will be measured and paid for as the actual number of linear feet of pipe measured along the flow line to the nearest foot which has been installed in non-soil, as observed and confirmed by the Engineer. Non-soil is defined as all material other than soil. The Contractor shall request and obtain the Engineer's observation and confirmation of the limits of the installation not in soil prior to and during the installation of the pipe or portion of the pipe not in soil.

Failure of the Contractor to request and obtain the Engineer's observation and confirmation of the limits of the pipe not in soil prior to and during the installation will result in the payment at the unit price for ___ *Inch Welded Steel Pipe In Soil.*

Such payment will include, but is not limited to furnishing all labor, tools, equipment, materials and incidentals, miscellaneous grading or excavation necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
__"Welded Steel Pipe in Soil	Linear Foot
__"Welded Steel Pipe Not in Soil	Linear Foot

SECTION 340
PIPE REMOVAL

340-1 DESCRIPTION

Remove and dispose of all existing roadway drainage pipe, including flared end sections, where the removal of the existing pipes is required by the plans or as directed. Unless otherwise indicated on the plans, this work does not include the removal and disposal of any existing public or private water or sewage pipe or subsurface and shoulder drain pipe.

The Contractor has the option of leaving pipes in place and filling with flowable fill.

340-2 MATERIALS

If used, flowable fill shall meet the following requirements of Division 10:

Item	Section
Fine Aggregate ((Bottom ash, although not included in Article 1014-1, may also be used with permission of the Engineer.)	1014-1
Portland Cement	1024-1
Type IP Blended Cement	1024-1
Fly Ash	*1024-5
*Certain requirements of this article and ASTM C618 may be waived with the permission of the Engineer.	
Type 1S Blended Cement	1024-1
Water	1024-4
Chemical Admixtures	**1024-3

**High-air generators or foaming agents may be used in lieu of conventional concrete air-entraining agents with the permission of the Engineer.

Submit the proposed mix design(s) on M & T Form 312 at least 35 days prior to use. Have a testing laboratory that has been approved by the Department determine mix proportions based on laboratory trial batches meeting the following requirements:

	Excavatable	Non-Excavatable
Compressive Strength	150 psi (max.)@ 56 days	125 psi (min.) @ 28 days
	Approximate quantities per cubic yard	
Cement	40-100 lbs.	100-150 lbs.
Fly Ash	***	***

Fine Aggregate (SSD)	***	***
Water (approximate)	As Necessary	As Necessary
Air	0 - 35%	0 - 35%
*** Add amounts singly or in combination to make the mix yield one cubic yard.		

To achieve desired placement consistency, flowability may be adjusted by varying the water content, with appropriate quantitative changes in other materials. Less flowable mixes are desirable when it is necessary to put traffic back on a roadway quickly or when less buoyant fill is needed to backfill pipes that could float out of position. Mixes to be pumped will need fly ash.

State on Form 312 the intended use of the material. Accompany Form 312 with a listing of compressive strength of at least three 4" x 8" cylinders at the age of 28 or 56 days, depending on whether the mix is to be excavated or not. Air cure the cylinders during the entire period before testing. The Engineer will advise the Contractor in writing of the acceptability of the mix design.

340-3 CONSTRUCTION METHODS

Remove existing pipe when so designated on the plans or as directed.

When an existing pipe is encountered that is not shown on the plans, do not remove until the Engineer is notified of its presence and has directed its removal.

Where traffic is to be maintained, remove pipe in sections so that half the width of the roadway will be available to traffic.

Remove existing pipe in such a manner that any nearby facilities will not be damaged.

Backfill the area disturbed by the removal of an existing pipe in accordance with the sections of these Specifications applicable to the adjacent construction.

Salvaged pipe is the property of the Contractor unless otherwise indicated by the contract.

Discharge flowable fill material directly from the truck into the space to be filled, or by other approved methods. The mix may be placed full depth or in lifts as site conditions warrant.

340-4 MEASUREMENT AND PAYMENT

Pipe Removal will be measured and paid for as the actual number of linear feet of pipe and flared end sections, measured to the nearest 0.1 foot that has been removed in accordance with this section. No measurement and payment will be made for pipe removal when a new pipe is placed back in the same trench.

Flowable Backfill will be measured and paid for as the item for which it was substituted. In no case will payment for the use of flowable fill as a substitute be made for more than one deleted item of work.

Any additional backfill material that is necessary will be paid for at the contract unit price for Unclassified Excavation in accordance with the requirements of Article 225-7, or

at the contract unit price for Borrow Excavation in accordance with the requirements of Article 230-5, depending on the source of the material.

Payment includes but is not limited to removing pipe, hauling pipe, and all excavating and backfilling that may be necessary.

Payment will be made under

Pay Item	Pay Unit
Pipe Removal	Linear Foot

SECTION 350
PIPE CLEAN OUT

350-1 DESCRIPTION

Clean out silt accumulations and other debris from existing drainage pipes at locations shown on the plans and as directed.

350-2 CONSTRUCTION METHODS

Use a pipe clean out method that does not damage the existing pipe.

350-3 MEASUREMENT AND PAYMENT

Pipe Clean Out will be measured and paid for as the actual number of existing pipes, structure to structure, that have been cleaned out and accepted, except where the work of cleaning out the pipe was made necessary by the Contractor's negligence in taking appropriate erosion control measures. Such price and payment will be full compensation for cleaning out existing pipe and disposing of all silt and debris.

Payment will be made under

Pay Item	Pay Unit
Pipe Clean Out	Each

DIVISION 4
MAJOR STRUCTURES

SECTION 400
TEMPORARY STRUCTURES

400-1 DESCRIPTION

Furnish any design calculations and drawings that are required; furnish members and deck materials for structures, and any other materials that are necessary; erect, maintain, remove and dispose of temporary structures required for the maintenance of pedestrian, highway, and other traffic. Approaches to temporary structures are not a part of this work.

Construct temporary structures in accordance with the contract. Maintain traffic over the temporary structure in accordance with Division 11.

400-2 MATERIALS

Use materials for temporary structures that conform to the requirements of Division 10 of the Specifications or previously used materials conforming to the requirements of the Specifications. Obtain approval for the use of salvaged materials and materials not covered by Division 10 prior to their use. The use of untreated timber is allowed unless otherwise required.

400-3 PLANS

(A) Furnishing Plans

Use the plans for the structure furnished by the Department or submit a design in accordance with Subarticle 400-3(B)

Design the structure when the plans furnished by the Department do not include detail plans for the structure. For all contractor designs, furnish one set of design calculations and 11 sets of detail drawings of the structure in accordance with Subarticle 400-3(B).

Submit detail drawings and design calculations for temporary structures for review and comment prior to beginning work. Do not perform any work until the detail drawings are reviewed and accepted. Acceptance of such drawings does not relieve the Contractor of any responsibility for safely and continuously maintaining traffic.

(B) Design Requirements for Contractor Furnished Drawings

Provide temporary structures of such carrying capacity, dimensions, grades, and alignment as required by the contract, or as directed. Design temporary structures carrying highway and pedestrian traffic in accordance with the AASHTO *Standard Specifications for Highway Bridges*. Have a North Carolina Licensed Professional Engineer design and detail the temporary structure and construct the temporary structure in accordance with this design.

Indicate on the plans, the Specifications for the materials used in the temporary structure.

400-4 CONSTRUCTION REQUIREMENTS

Construct and maintain temporary structures to adequately and safely carry traffic during the entire period for which they are required.

Remove and dispose of the temporary structures after they are no longer required in accordance with Article 402-2.

Upon removal of the temporary structure, all material furnished by the Contractor for use in this structure is the property of the Contractor unless otherwise provided in the contract.

Remove temporary piling to the streambed level or to 1 foot below existing ground.

400-5 MEASUREMENT AND PAYMENT

The price and payment below will be full compensation for all items required to provide temporary structures including but not limited to those items contained in Article 400-1.

The work covered by this section will be paid for at the contract lump sum price for *Construction, Maintenance, and Removal of Temporary Structure at Sta.* _____.

Payment will be made under:

Pay Item	**Pay Unit**
Construction, Maintenance, and Removal of Temporary Structure at Sta. ____	Lump Sum

SECTION 402
REMOVAL OF EXISTING STRUCTURES

402-1 DESCRIPTION

Excavate as necessary to remove the structure; dismantle, salvage, and stockpile materials and components of the structure and preserve those portions that should remain intact, and dispose of waste and debris.

Maintain traffic over the existing structure in accordance with Division 11 unless otherwise stipulated by the contract. Comply with the posted load limits of the existing structure. The maintenance of the existing structure, if required, will be performed by Department forces.

402-2 REMOVAL OF EXISTING STRUCTURE

(A) General

Use approved methods and operations for removal of structures. Upon removal, all materials become the property of the Contractor unless otherwise indicated in the contract. Dispose of waste and debris from the structures in accordance with Section 802.

Perform removal operations while preventing damage to adjacent property. Protect new construction during blasting or other operations necessary for the removal of the existing structure.

Unless otherwise required by the contract, remove substructures down to the streambed or 1 foot below the natural ground surface. Remove the substructure as necessary to avoid interference with construction of the proposed structure.

Prevent erosion of soil and silting of rivers, streams, lakes, reservoirs, water impoundment, ground surfaces, or other property. Do not deposit excavated materials and do not construct earth dikes or other temporary earth structures in rivers, streams, or impoundment or so near to such waters that they are carried into any river, stream, or impoundment by stream flow or surface runoff. Limit the use of equipment in any body of water to those operations that are impossible or impractical to perform in any other way, and control them as to minimize erosion and siltation. Do not drop components of structures into any body of water. Remove existing bridges over water by sawing or other non-shattering methods. Submit, and await approval for, a plan for bridge demolition for these bridges prior to beginning removal. Remove any component of a structure from the water so as to minimize siltation.

(B) Requirements for Materials Which Remain the Property of the Department

Pile materials salvaged from the structure neatly on the right of way at locations as directed.

Do not use any materials, either temporarily or permanently, which are removed from the structure unless so permitted by the contract.

Remove structural materials carefully without damage.

Do not use explosives to remove concrete floor slabs from steel superstructures that remain the property of the Department.

(C) Requirements for Partial Removal

Perform partial removal true to the lines indicated on the plans. Submit, and await approval for, a plan for partial removal of bridges prior to beginning removal. Do not remove concrete by blasting or other method that may cause damage to the concrete or reinforcement that is used in the completed structure.

Use equipment and methods to remove portions of a concrete structure undergoing widening which are sufficient to obtain plan lines and slopes without undue spalling at edges of the concrete. Do not use an iron ball or pile hammer to remove portions of a concrete structure undergoing widening.

402-3 MEASUREMENT AND PAYMENT

The price and payment below will be full compensation for all items required to remove temporary structures including but not limited to those items contained in Article 402-1.

When the contract includes the item of *Removal of Existing Structure at Sta. _____*, the work of removing the structure will be paid for at the contract lump sum price for this item.

Payment will be made under:

Pay Item	Pay Unit
Removal of Existing Structure at Sta.____	Lump Sum

SECTION 410
FOUNDATION EXCAVATION

410-1 DESCRIPTION

Excavate any material as necessary for the construction of foundations and end bent caps for bridges, retaining walls of reinforced concrete or reinforced masonry, arch culverts, and box culverts without floor slabs in accordance with the contract, or as directed. Excavate, perform exploratory drilling at footings to a depth not to exceed 5 feet, blast, drain and divert water, bail, and pump. Provide and remove bracing, shoring, sheeting, cribbing, and cofferdams; substructure scour protection, subsurface drainage, drawings; and backfill, haul, and dispose of materials.

Do not deposit excavated materials or construct earth dikes or other temporary earth structures in rivers, streams, or impoundment or so near to such waters that they are carried into any river, stream, or impoundment by stream flow or surface runoff. As an exception to the above, obtain written approval for the use of confined earth materials in cofferdams for structure foundations.

410-2 MATERIALS

Refer to Division 10

Item	Section
Subdrain Fine Aggregate	1044-1
Stone, No. 78M	1005

410-3 FOUNDATION EXCAVATION

Notify the Engineer in sufficient time before beginning the excavation to allow measurements of the undisturbed ground.

Where necessary for safety, slope, shore, brace, or protect by cofferdams the foundation openings in accordance with local and State safety standards. Perform foundation excavation and related work in such sequence that no portion of the structure is endangered by subsequent operations. Adequately protect completed portions of a structure during blasting operations.

Consider the dimensions and elevations of footings, as shown on the plans as approximate only. The Engineer may order, in writing, such changes in dimensions or elevations of footings as necessary to secure a satisfactory foundation.

Notify the Engineer after excavating each foundation. Do not place concrete prior to obtaining approval for the excavation depth, the character of the foundation, and permission to proceed. Perform drilling as may be required by the Engineer in order to obtain

information as to the depth to which the rock or other hard foundation material extends below the bottom of the footing.

Clean all rock or other hard foundation material of all loose material and cut to a firm surface, either level, stepped, or serrated, as directed. Clean out all seams and fill with concrete, mortar, or grout. Remove all loose and disintegrated rock and thin strata. Leave the rock surface in a rough condition to form an adequate key against lateral movement of the footing.

When the footing rests on an excavated surface other than rock, take special care not to disturb the bottom of the excavation until immediately before placing reinforcing steel and concrete. Remove foundation material softened and weakened by exposure and inundation down to sound, solid material before placing steel and concrete.

When using foundation piles, complete the excavation of each pit before driving piles.

When pile driving liquefies the soil, or the bed is otherwise unsuitable as determined by the Engineer, remove the material as required and backfill to the required elevation with an approved granular material. Such work will be paid for as extra work in accordance with Article 104-7.

410-4 COFFERDAMS

(A) General

The term cofferdam designates any temporary or removable structure constructed to hold the surrounding earth, water, or both, out of the excavation. It includes timber cribs, any type of sheet piling, removable steel shells, or similar structures, all necessary bracing, and the use of pumping wells or well points for the same purpose. Have cofferdams located in bodies of water designed, detailed, and sealed by a North Carolina Licensed Professional Engineer when the distance from the water surface to the bottom of the excavation is 5 feet or greater.

(B) Construction

Design and construct cofferdams to adequate depths and heights, safely, and as watertight as is necessary for the proper performance of the work. Provide interior dimensions of cofferdams as to give sufficient clearance for the construction and inspection of forms and to permit pumping outside the forms. Provide at least 5 feet of clearance between the proposed edge of footing and inside face of cofferdam when a keyed footing is required and at least 3 feet when a keyed footing is not required. Right, rest, or enlarge cofferdams that are tilted or moved laterally during the process of sinking to provide the necessary clearance.

Construct cofferdams to protect plastic concrete against damage from a sudden rising of the stream and to prevent damage to the foundation by erosion. Do not leave timber or bracing in cofferdams that could extend into the substructure concrete without permission.

(C) Removal

After the completion of the substructure, unless otherwise provided in the contract, remove cofferdams with all sheeting and bracing to the stream bed or 1 foot below existing ground. Take care not to disturb or injure the finished concrete.

410-5 PUMPING

Perform pumping operations in accordance with Article 414-5.

410-6 PRESERVATION OF CHANNEL

Unless otherwise required by the contract or permitted by the Engineer, do not excavate in stream channels outside of cofferdams. Do not disturb the natural stream bed adjacent to the structure without permission. Backfill any excavation or dredging made at the site of the structure outside of the cofferdam limits to the original ground surface or river bed with approved material.

Remove materials placed within the stream area and leave the stream in its original condition, unless otherwise permitted.

410-7 UTILIZATION OF EXCAVATED MATERIAL

Use suitable excavated material as backfill. Use suitable material that is not required for backfill to form embankments, subgrades, or shoulders. When so used, no additional payment will be made for utilization of the material under other pay items or for stockpiling the material for use under other pay items. Furnish disposal areas for excavated unsuitable materials and suitable materials not required in connection with other work included in the contract. Do not place excavated material in a stream or other body of water or wetland.

Do not deposit excavated material at any time so as to endanger the partly finished structure, either by direct pressure or indirectly by overloading banks adjacent to the operations, or in any other manner.

410-8 BACKFILLING AND FILLING

Use approved material for backfill that is free from large or frozen lumps, wood, or other undesirable material. Where there is not an adequate quantity of suitable backfill material available from the excavation, provide suitable backfill material compensated in accordance with Subarticle 410-12.

Refill all excavated spaces not filled with permanent work with earth up to the ground surface existing before the excavation. Place backfill to provide adequate drainage as soon as concrete surfaces are finished in accordance with Subarticle 420-17(B) and the concrete is inspected and approved. The Engineer has the authority to suspend all operations until such backfilling is acceptably completed.

Eliminate any slope adjacent to the excavation for abutments, wingwalls, and retaining walls by stepping or serrating to prevent wedge action.

Compact all portions of the backfill that become a part of roadway typical sections or their foundations in accordance with Subarticle 235-4(C). Place all other portions of the backfill in layers not more than 6" in depth of loose measure and compact to a density comparable to the adjacent undisturbed material.

Place backfill or embankment material simultaneously insofar as possible to approximately the same elevation on both sides of an abutment, pier, or wall. If conditions require placing backfill or embankment higher on one side, do not place the additional material on the higher side until the concrete develops the minimum specified strength for the class of concrete required for the structure.

Do not place backfill or embankment behind the walls of concrete culverts, abutments of bridges other than rigid frames, or abutments of rigid frame structures until the top slab is placed and has developed the minimum compressive strength required by Article 420-20. Place backfill and embankment simultaneously behind opposite abutments of rigid frames or sidewalls of culverts. Place backfill for abutments of bridges to a minimum elevation of 1 foot below the bridge seats before setting beams or girders.

Place backfill so as not to cause excess lateral forces against the structure by heavy equipment or from earth masses transmitting pressures caused by earth moving equipment. Place backfill immediately adjacent to the structure by hand operated mechanical tampers. Do not operate heavy earth moving equipment within 10 feet of the structure in backfilling operations.

410-9 SUBSURFACE DRAINAGE AT WEEP HOLES

Place a stone drain consisting of 1 cubic foot of No. 78M stone contained in a bag of porous fabric at each weep hole. Place subdrain fine aggregate beneath, around, and over the stone drain so that the stone drain is covered by a layer of subdrain fine aggregate at least 1 foot thick. Connect all drains with a horizontal drain of subdrain fine aggregate at least 1 foot square in cross section. In the case of abutments and retaining walls, in addition to the above requirements, place a vertical drain of subdrain fine aggregate at least 1 foot square in cross section at each weep hole to an elevation 2 feet below the subgrade or surface of the embankment.

When embankment placement around the structure is part of another contract, the portion of the subsurface drainage system described above, which is located in such embankment, is not considered part of the work of this section.

410-10 SUBSTRUCTURE SCOUR PROTECTION

Provide substructure scour protection as indicated in the plans. Place the two to six inch size stone after removing footing formwork and while dewatering the excavation. Place the rip rap stone before removing the cofferdam sheeting, either before or after allowing the excavation to flood. When not using sheeting, place each stone type to the required thickness and extend horizontally to the undisturbed material.

Use two to six inch size Scour Protection Stone which is hard and durable in nature. While no specific gradation is required, distribute the various sizes of stone reasonably equally within the required size range. Use stone that is essentially cubical in shape.

410-11 BLASTING ADJACENT TO HIGHWAY STRUCTURES

Conduct blasting operations adjacent to highway structures in accordance with the following requirements.

Submit and await approval of a blasting plan prior to conducting any blasting operation.

Do not conduct blasting operations within 60 feet of any structure until the concrete strength reaches 2400 psi. After the concrete achieves a strength of 2400 psi, limit the maximum peak particle velocity to 4 in./sec. measured at the closest structure extremity.

For multi-column bents with column heights up to 40 feet and a combined span length for the two adjacent spans of 160 feet or less, adhere to the following criteria:

(A) Do not blast within 6 feet without obtaining prior written approval.

(B) At distance of 6 to 10 feet do not use a quantity of explosives more than 0.5 pound per delay period.

(C) From 11 to 60 feet, use a maximum charge weight per delay of 0.5 pound + 0.5 pound of explosives per foot of distance over 10 feet.

No vibration measurements are required if the above criteria are met. If unable to meet the above criteria, monitor the structure with an engineering seismograph to determine whether the 4-in./sec. limit is exceeded. If the 4 in./sec. limit is exceeded, the Engineer will evaluate each subsequent blast, and if deemed necessary, will apply more restrictive controls than those above to prevent damage.

Payment of blasting operations is included in the bid price for Foundation Excavation at the affected substructure unit.

410-12 MEASUREMENT AND PAYMENT

Foundation Excavation on a Cubic Yard Basis

When the contract calls for payment of foundation excavation on a cubic yard basis, it will be measured and paid on a cubic yard basis for the actual number of cubic yards of materials, measured in their original position within the limits described below and computed by the average end area method, that are acceptably excavated.

The upper limits for measurement are the actual ground surface at the time of starting work, except that where the excavation is performed in cut areas excavated under Section 225, the upper limits are the roadway plan typical section. For keyed footings the upper limits of the keyed section are as shown on the plans. A keyed footing is a footing that is placed without forms for the keyed depth in an excavation whose sides, as near as practicable, are located at the neat line dimensions of the footing and are vertical.

When the foundation material is other than rock, the lower limits for measurement are the elevation of the bottom of footing as established by the plans or as directed. When the foundation material is rock, the lower limits for measurement are the actual rock elevations after the foundation is approved.

As an exception to the lower limits established above, when in the opinion of the Engineer excess excavation is performed due to carelessness or negligence on the part of the Contractor, the Engineer notifies the Contractor of that portion of the excavation which is not measured for payment.

Horizontal limits for measurement are established by vertical planes located 18" outside of the neat line dimensions of the footing as established by the plans or directed in writing by the Engineer. For keyed footings the horizontal limits for measurement of the keyed

section are established by vertical planes located at the neat line dimensions of the footing as established by the plans or directed in writing.

Measurement includes mud, muck, or similar semi-solid material within the limits described above provided such material is present at the time excavation begins and cannot be drained away or pumped without the use of a jet or nozzle.

No measurement is made of the following excavation, as such excavation is considered incidental to the work covered by this section:

Excavation necessary to construct end bent caps and the berm adjacent to the cap.

Excavation necessary to construct pile encasement.

Excavation outside of the limits described in this subarticle.

Excavation necessary from heaving of a foundation due to the driving of piles.

Excavation necessary from overbreaks or slides.

Mud, muck, or similar semi-solid material which can be drained away or pumped without the use of a jet or nozzle.

Excavation made before the Engineer makes measurements of the undisturbed ground.

Excavation necessary due to exposure or inundation allowed by the Contractor, or carelessness on the part of the Contractor.

Foundation excavation will be paid for at the contract unit price per cubic yard for Foundation Excavation except as otherwise provided below.

Where the Engineer directs the Contractor in writing to excavate below the original plan elevation of the bottom of the footing, payment for such excavation will be made as follows:

For excavation made below the original plan elevation of the bottom of the footing to an elevation 3 feet below such plan elevation, payment will be made at the contract unit price per cubic yard for *Foundation Excavation*.

For excavation made below an elevation 3 feet below the original plan elevation of the bottom of the footing but not more than 6 feet below such plan elevation, payment will be made at 150 percent of the contract unit price per cubic yard for Foundation Excavation.

For excavation made below an elevation 6 feet below the original plan elevation of the bottom of the footing, payment will be made as provided in Article 104-7 for extra work.

In areas where piles have been driven, removal of material and backfilling with approved granular material, in accordance with Article 410-3, will be paid for as extra work as provided in Article 104-7.

Foundation Excavation on a Lump Sum Basis

When the contract calls for payment of *Foundation Excavation* on a lump sum basis, no measurement will be made of any foundation excavation made at such locations.

The prices and payments below will be full compensation for all items required to complete foundation excavation.

When the contract calls for payment on a lump sum basis, payment will be made at the contract lump sum price for *Foundation Excavation for Bent No. _____ at Station _____*, or *Foundation Excavation for End Bent No. ___ at Station ___* except as otherwise provided below.

Where the Engineer directs the Contractor to excavate below the original plan elevation of the bottom of the footing by a distance which is less than 3 feet the character of the work will not be considered to be materially changed and no additional compensation will be allowed for the foundation excavation at such location.

Where the Engineer directs the Contractor in writing to excavate more than 3 feet below the original plan elevation of the bottom of the footing, payment for such excavation will be made as provided in Article 104-7 for extra work.

Furnishing and Hauling Backfill Material

Where it is necessary to provide backfill material from sources other than excavated areas or borrow sources used in connection with other work in the contract, payment for furnishing and hauling such backfill material is made as provided in Article 104-7 for extra work. Placing and compacting such backfill material is not considered as extra work, but is considered incidental to the work covered by this section.

When the Contractor has been directed by the Engineer to drill in the vicinity of a footing to obtain subsurface information, such drilling in excess of a 5-foot depth will be paid for as provided in Article 104-7 for extra work.

Payment will be made under:

Pay Item	Pay Unit
Foundation Excavation	Cubic Yard
Foundation Excavation for Bent No. _____ at Station ____	Lump Sum
Foundation Excavation for End Bent No. ___ at Station ___	Lump Sum

SECTION 412
UNCLASSIFIED STRUCTURE EXCAVATION

412-1 DESCRIPTION

Excavate any material not classified as foundation excavation, box culvert excavation, or channel excavation whose removal is required for the construction of bridges, retaining walls of reinforced concrete or reinforced masonry, arch culverts, and box culverts without

floor slabs, and which is classified as unclassified structure excavation on the plans, in accordance with the contract or as directed. Excavate, blast, brace, shore, provide sheeting and cribbing, backfill, haul, and dispose of materials.

Do not deposit excavated materials, nor construct earth dikes or other temporary earth structures, in rivers, streams, or impoundment or so near to such waters that they are carried into any river, stream, or impoundment by stream flow or surface runoff.

Dispose of all timber, stumps, and debris in accordance with Article 200-5.

412-2 PRESERVATION OF CHANNEL

Unless otherwise required by the contract, do not excavate in stream channels. Do not disturb the natural stream bed adjacent to the structure without permission.

Do not place material in a stream without approval. Remove materials placed within the stream area and leave the stream in its original condition, unless otherwise permitted.

412-3 UTILIZATION OF EXCAVATED MATERIAL

Use and place suitable excavated material in accordance with the requirements of Articles 410-7 and 410-8.

Notify the Engineer a sufficient time before beginning the excavation so that measurements may be taken of the undisturbed ground.

412-4 MEASUREMENT AND PAYMENT

Unclassified Structure Excavation will be measured and paid for as the actual number of cubic yards of materials, measured in their original position and computed by the average end area method, which is acceptably excavated in accordance with the contract or as directed by the Engineer. Original cross sections for the determination of excavation quantities are taken before any excavation is done.

No measurement is made of any materials excavated outside of the limits shown on the plans or directed in writing by the Engineer, or any materials excavated before the Engineer makes measurements of the undisturbed ground.

The price and payment below will be full compensation for all items required to complete unclassified structure excavation including but not limited to those items contained in Article 412-1.

When the contract includes the item of *Unclassified Structure Excavation at Station* __ the work will be paid for at the contract lump sum price.

Payment will be made under:

Pay Item	Pay Unit
Unclassified Structure Excavation	Cubic Yard
Unclassified Structure Excavation at Station _____	Lump Sum

SECTION 414
BOX CULVERT EXCAVATION

414-1 DESCRIPTION

Excavate all material necessary for the construction of box culverts with floor slabs in accordance with the contract or as directed. Excavate, blast, drain and divert water, bail, pump, brace, shore, provide sheeting, cribbing, cofferdams, culvert foundation conditioning, subsurface drainage and drawings; backfill, haul, and dispose of materials.

Do not deposit excavated materials, nor construct earth dikes or other temporary earth structures in rivers, streams, or impoundment or so near to such waters that they are carried into any river, stream, or impoundment by stream flow or surface runoff. As an exception to the above, obtain written approval for the use of confined earth materials in cofferdams for structure foundations.

414-2 MATERIALS

Refer to Division 10:

Item	Section
Subdrain Fine Aggregate	1044-1
Stone, No. 78M	1005
Foundation Conditioning Material	1016

414-3 FOUNDATION EXCAVATION

Notify the Engineer a sufficient time before beginning the excavation so that measurements may be taken of the undisturbed ground if desired by the Engineer. Do not disturb the existing ground at the culvert site without permission.

Where necessary for safety, slope, shore, brace, or protect by cofferdams the foundation openings in accordance with local and State safety standards. Perform foundation excavation and related work in such sequence that no portion of the culvert will be endangered by subsequent operations. Protect completed portions of a culvert from blasting.

Remove and dispose of boulders, vegetative matter, and any other objectionable material.

Notify the Engineer after excavating each foundation. Do not place any concrete until obtaining approval of the excavation depth, the character of the foundation material and permission to proceed.

Take special care not to disturb the bottom of the excavation until immediately before placing reinforcing steel and concrete.

414-4 CONDITIONING CULVERT FOUNDATION

Excavate to a depth as directed below the bottom of the barrel or wing footing and replace the excavated material with foundation conditioning material.

When the foundation material beneath a portion of the barrel or wing footing is rock or incompressible material, and softer material is beneath the remainder of the barrel or wing footing, excavate the rock material within the neat lines of the barrel or footing to a depth of 12" below the bottom of the barrel and footings and backfill with foundation conditioning material.

Use Class VI, Select Material foundation conditioning material as defined in Section 1016.

414-5 PUMPING

Pump from the interior of any foundation enclosure in such a manner as to preclude the possibility of the movement of water over or through any fresh concrete. Do not pump while placing concrete or for a period of at least 24 hours thereafter, unless done from a suitable sump separated from the concrete work by a substantially watertight wall.

414-6 UTILIZATION OF EXCAVATED MATERIAL

Use suitable excavated material in accordance with Article 410-7.

414-7 BACKFILLING AND FILLING

As soon as practical after completing the box culvert, place the backfill and redirect the stream through the culvert.

Use approved material for backfill that is free from large or frozen lumps, wood, or other undesirable material. Where there is not an adequate quantity of suitable backfill material available from culvert excavation, provide suitable backfill material compensated as provided in Subarticle 410-12.

Eliminate any excavated slope adjacent to backfill areas by stepping or serrating to prevent wedge action.

Compact all portions of the backfill that become a part of roadway typical sections or their foundations in accordance with Subarticle 235-4(C). Place all other portions of the backfill in layers not more than 6" in depth of loose measure and compact to a density comparable to the adjacent undisturbed material. Refill all excavated spaces not filled with permanent work with earth up to the ground surface existing before the excavation.

Do not place backfill or embankment behind the walls of culverts until after placing the top slab and allowing development of the minimum compressive strength required by Article 420-20.

Place backfill or embankment material simultaneously insofar as possible to approximately the same elevation on both sides of the culvert and do not carry it to an elevation higher than 1 foot above the top of footing or bottom slab until the concrete develops the minimum required strength for the class of concrete used.

414-8 SUBSURFACE DRAINAGE AT WEEP HOLES

Place subsurface drainage in accordance with Article 410-9.

414-9 MEASUREMENT AND PAYMENT

The prices and payments below will be full compensation for all items required to complete box culvert excavation including but not limited to those items contained in Article 414-1.

Foundation Conditioning Material, Box Culvert will be measured and paid for in tons of material that is placed within the established limits. The number of tons of material is determined by weighing the material in trucks in accordance with the requirements of Article 106-7. No deduction will be made for any moisture contained in the material at the time of weighing. Such price and payment will be full compensation for all excavation made below the bottom of the barrel and wing footings in addition to furnishing, hauling, and placing the foundation conditioning material.

Culvert Excavation, Sta. _____" will be paid for at the contract lump sum price. No measurement for payment will be made for this pay item, and no adjustment in the contract lump sum price will be made unless the size, length, elevation, or location of the culvert is revised. In the event of a revision in the size, length, elevation, or location of the culvert, such revision will be considered an alteration of plans or details of construction in accordance with Article 104-3.

Where it is necessary to provide backfill material from sources other than excavated areas or borrow sources used in connection with other work in the contract, payment for furnishing and hauling such backfill material is made as provided in Article 104-7 for extra work. Placing and compacting such backfill material is not considered extra work, but is considered incidental to the work covered by this section.

Payment will be made under:

Pay Item	Pay Unit
Culvert Excavation, Sta. _____	Lump Sum
Foundation Conditioning Material, Box Culvert	Ton

SECTION 416
CHANNEL EXCAVATION

416-1 DESCRIPTION

Excavate any material outside of the pay limits of foundation excavation, unclassified structure excavation, or box culvert excavation, which is classified as channel excavation in the plans. Place suitable excavated material as directed, drain and divert water, pump, blast, haul, dispose of materials, and backfill.

Do not deposit excavated materials, nor construct earth dikes or other temporary earth structures in rivers, streams, or impoundment or so near to such waters that they are carried into any river, stream, or impoundment by stream flow or surface runoff.

416-2 CONSTRUCTION REQUIREMENTS

Notify the Engineer a sufficient time before beginning the excavation so that measurements may be taken of the undisturbed ground. Do not disturb the existing ground without permission.

Remove and dispose of boulders, vegetative material, and any other objectionable material.

Use and place suitable excavated material in accordance with the requirements of Articles 410-7 and 410-8.

416-3 MEASUREMENT AND PAYMENT

Channel excavation will be measured and paid for on a cubic yard basis. Materials will measured in their original position within the limits described below and computed by the average end area method, that are acceptably excavated in accordance with the contract or as directed. The upper limits for measurement are the actual ground surface at the time of starting work. The lower limits for measurement are established by the plans or as directed in writing.

No measurement is made of the following excavation:

Mud, muck, or similar semi-solid material which can be drained away or pumped without the use of a jet or nozzle.

Excavation before the Engineer makes measurements of the undisturbed ground.

Excavation that is within the pay limits of other excavation.

Excavation that is outside of the limits shown on the plans or as directed in writing.

Where the item *Channel Excavation* is not included in the contract, no measurement or payment is made of any channel excavation, as payment at the contract unit or lump sum price for the various items in the contract will be full compensation for the work covered by this section.

This price and payment will be full compensation for all items required to complete channel excavation.

Payment will be made under:

Pay Item	Pay Unit
Channel Excavation	Cubic Yard

SECTION 420
CONCRETE STRUCTURES

420-1 DESCRIPTION

Construct cast-in-place concrete structures and the cast-in-place concrete portions of composite structures in conformity with the lines, grades, and dimensions shown in the contract. Furnish and place concrete, joint filler and sealer, curing agents, epoxy protective coating, deck drains, expansion anchors, and any other material; erect and remove all falsework and forms; protect concrete in wind, rain, low humidity, high temperatures, or other unfavorable weather; construct joints and weep holes; finish and cure concrete; protect concrete from rust stains; and groove bridge floors. For reinforced concrete deck slabs, in addition to the above, furnish and place reinforcing steel and bridge scuppers; and design, furnish, erect, and remove all bridge deck forms including any appurtenances required by the Engineer to stabilize exterior girders during overhang construction.

420-2 MATERIALS

Refer to Division 10:

Item	Section
Portland Cement Concrete	1000
Reinforcing Steel	1070
Curing Agents	1026
Joint Fillers	1028-1
Joint Sealers	1028
Deck Drains	1054-3
Expansion Anchors	1074-2
Metal Stay-in-Place Forms	1074-12
Calcium Nitrite Corrosion Inhibitor	1000-4(K)
Epoxy Protective Coating	1081

420-3 FALSEWORK AND FORMS

(A) General

Submit 8 sets of detailed drawings for falsework or forms for bridge superstructure and other components as required by the contract for review, comments and acceptance before beginning construction of the falsework or forms. This review does not relieve the Contractor of full responsibility for the safety, alignment, quality, or finish of the work.

Design falsework and forms to carry the full loads upon them, including a dead load of 150 pounds per cubic foot for concrete, loads caused by equipment and personnel, and for lateral pressures resulting from rate of pours, setting times, and effects of vibration on the concrete, so that the finished concrete surface conforms to the proper dimensions and contours and has an even appearance.

Use lumber and other material for forms and falsework that is sound and in good condition.

Set falsework and forms to give the correct elevation shown on the drawings making proper allowance for shrinkage, deflections, and settlement, and maintain true to lines and grades designated until the concrete sufficiently hardens.

Where falsework or forms appear to be unsatisfactorily built in any respect either before or during placing of concrete, the Engineer will order the work stopped until the defects are acceptably corrected.

Keep the falsework and forms in place after placing of concrete for the periods specified in Article 420-16. Remove falsework and forms in an acceptable manner. Do not leave forms or falsework permanently in place without written approval.

Provide a means, satisfactory to the Engineer, to check any settlement or deflection that may occur during the placing of concrete in the various portions of the work.

(B) Falsework

Build falsework on foundations of sufficient strength to carry the applied loads without appreciable settlement. Support falsework that cannot be founded on solid footings on ample falsework piling.

Use an acceptable method to compensate for shrinkage, deflection, and settlement. Use jacks in order to readily effect adjustment, if necessary, before or during placing of concrete, if required by the Engineer.

(C) Forms

(1) General

Use forms made of wood or steel except where other materials are specified by the contract or accepted by the Engineer.

(2) Wood Forms

Build forms mortar-tight of material sufficient in strength with ample studding, walling, and bracing to effectively prevent any appreciable horizontal and/or vertical deflection.

Provide forms with interior dimensions such that the finished concrete is of the form and dimensions shown on the plans.

Line forms, except for surfaces permanently in contact with earth fill, with plywood or other approved material. Provide a lining with a smooth and uniform texture and of such thickness and rigidity that a concrete surface of uniform texture and even appearance results. Provide joints between form liners that are mortar tight and even and maintain to prevent the opening of joints due to the shrinkage of the lumber.

Fillet forms at all sharp corners unless otherwise noted on the plans. Mill wood chamfer strips from straight grained lumber and surface on all sides.

Give forms for all projections a bevel or draft to insure easy removal.

At all times, maintain the shape, strength, rigidity, watertightness, and surface smoothness of reused forms. Resize any warped or bulged lumber before

reusing. Do not reuse any forms that are unsatisfactory in any respect. Do not use plywood sheets showing torn grain, worn edges, patches or holes from previous use, or other defects that impair the texture of concrete surfaces exposed to view.

Maintain an acceptable alignment and no broken edges on all chamfer strips.

Thoroughly clean forms previously used of all dirt, mortar, and foreign material before reusing. Before placing concrete in forms to be removed, thoroughly coat all inside surfaces of the forms with commercial quality form oil or other equivalent coating which permits the ready release of the forms and does not discolor the concrete.

Construct or install metal spacers or anchorages, required within the forms for their support or to hold them in correct alignment and location, in such a way that the metal work can be removed to a depth of at least 1" from the exposed surface of the concrete without injury to such surface by spalling or otherwise. Limit the diameter to not greater than 1½ times its depth for the recess formed in the concrete. Cut back all such metal devices in exposed surfaces, upon removal of the forms, to a depth of at least 1" from the face of the concrete. Carefully fill cavities produced by the removal of metal devices with cement mortar of the same mix used in the body of the work immediately upon removal of the forms, and leave the surface smooth, even, and as nearly uniform in color as possible. As an option, break off flush with the concrete surface those metal devices with cross sectional area not exceeding 0.05 square inches on surfaces permanently in contact with earth fill.

Do not weld metal devices to either reinforcing steel or structural steel that is a permanent part of the structure without written approval.

(3) Steel Forms

Apply the requirements of Subarticle 420-3(C)(2) in regards to design, mortar tightness, filleted corners, beveled projections, bracing, alignment, texture and evenness of appearance of the resulting concrete surface, removal, re-use, and oiling to steel forms. Use steel for forms of such thickness that the forms remain true to shape. Counter-sink bolt and rivet heads. Design clamps, pins, or other connecting devices to hold the forms rigidly together and allow removal without injury to the concrete. Do not use steel forms that do not present a smooth surface or line up properly. Exercise care to keep steel forms free from rust, grease, or other foreign matter that will tend to discolor the concrete.

(D) Forms for Concrete Bridge Decks

In addition to the requirements of Subarticles 420-3(C)(1) through 420-3(C)(3), the following requirements apply to falsework and forms used to construct reinforced concrete bridge decks on girders. Furnish all materials, labor, equipment and incidentals necessary for the proper installation of falsework and forms for concrete bridge deck slabs.

For prestressed girder spans, the plans for the concrete deck slab are detailed for the use of a cast-in-place slab using either precast prestressed concrete panels or fabricated metal stay-in-place forms; however, as an option, construct a cast-in-place slab using removable forms. If noted on the plans, the option is available to use metal stay-in-place forms in lieu of precast prestressed concrete panels.

For structural steel spans, plans for the concrete deck slab are detailed for the use of metal stay-in-place forms; however, as an option, construct a cast-in-place slab using removable forms. Do not use precast prestressed concrete panels on structural steel spans.

If using a form system other than that detailed on the plans, do so at no additional cost to the Department. Changes in slab design to accommodate the use of optional forms are the responsibility of the Contractor. Submit these changes for review and approval. Prior to using optional forms, submit two sets of prints of detailed checked plans of the system and checked design calculations for the composite slab complying to the latest *AASHTO Standard Specifications* and *Highway Design Branch Structure Design Manual*. After the drawings are reviewed and, if necessary, the corrections made, submit reproducible drawings of the deck system to become the revised plans. Ensure that the size of the sheets used for the drawings is 22" x 34". Ensure that the plans and design calculations are checked and sealed by a North Carolina Licensed Professional Engineer.

Where reinforced concrete deck slab with sand lightweight concrete is required by the contract, do not use precast prestressed concrete panels.

Unless otherwise shown on the plans, use the same forming system for all of the same type superstructure spans within the bridge. Construct the slab overhang from the exterior girder to the outside edge of superstructure using removable forms.

(1) Precast Prestressed Concrete Panels

Prestressed concrete panels are subject to the requirements for prestressed concrete members as specified in Section 1078, the plans, and these Specifications.

Design prestressed panels subject to review by the Engineer. Prior to using prestressed panels, submit 7 sets, including one reproducible set, of detailed plans of the panels for review. Submit with the checked plans 1 set of checked design calculations for the panels complying with the latest *AASHTO Standard Specifications*, requirements detailed herein, and the plans. Have the plans and design calculations checked and sealed by a North Carolina Licensed Professional Engineer. If corrections to the drawings are necessary, submit 1 set of corrected reproducible drawings. Use a plan sheet size of 22" x 34". The drawings become part of the plans.

Design the prestressed concrete panels in accordance with the following criteria:

(a) Design details to provide a mating surface joint or a draft not exceeding 1/8" resulting in a joint that is closed at the top and a maximum of 1/4"

open at bottom of panel. Detail the joints filled with grout or other methods approved by the Engineer to prevent leakage of the concrete. Place a chamfer or fillet, with a 3/4" horizontal width, along the top edges of the panel parallel with the prestressed girder.

(b) Design panels to support the dead load of the panel, reinforcement, plastic concrete and a 50 pounds per square foot construction load. Design the panel and slab acting compositely to support design live loads and dead loads acting on the composite section. Include in the design dead load acting on the composite section an additional load of 20 pounds per square foot for a future asphalt wearing surface. For bridges up to 44 feet in width distribute equally to all deck panels superimposed dead loads for such permanent bridge items as barrier rails, medians or any dead load which is applied after the deck is cast. In the case of bridges over 44 feet wide, distribute these loads equally to the first 2 1/2 panels adjacent to each side of the load.

(c) The design span of the prestressed concrete panel is the clear distance between edges of girders plus 2" measured parallel to the panel edges.

(d) Limit tension in the precompressed tensile zone to 424 psi unless the plans require 0-psi tension.

(2) Fabricated Metal Stay-In-Place Forms

Furnish metal stay-in-place forms with closed tapered ends to form the concrete deck slabs as shown on the plans. Submit 8 copies of complete fabrication and erection drawings for review, comments and acceptance. When required by the design plans, detail SIP forms with excluder plates to exclude concrete from the valleys in the forms. Styrofoam void fillers may be used in SIP metal forms with the following stipulations:

Adhesive shall be used on all three contacting sides of the styrofoam void fillers rather than on the bottom only.

The adhesive shall be compatible with the styrofoam material so as not to cause the styrofoam to decompose.

Duct tape shall not be used to hold the styrofoam in place.

Styrofoam shall be placed in one piece across each bay, and be trimmed so as not to extend over the girder.

Styrofoam damaged during placement of reinforcing steel shall be replaced.

Indicate on these plans the grade of steel, the physical and section properties for all permanent steel bridge deck form sheets and a clear indication of

locations of form supports. Do not fabricate the forming material until drawings are accepted.

Design metal stay-in-place forms in accordance with the following criteria:

(a) Accommodate the dead load of the form, reinforcement and the plastic concrete, including the additional weight of concrete due to the deflection of the metal forms, plus 50 pounds per square foot for construction loads. Do not allow the unit working stress in the steel sheet to exceed 72.5% of the specified minimum yield strength of the material furnished nor 36 ksi.

(b) Limit the horizontal leg of the support angle to 3". Design the support angle as a cantilever.

(c) Limit the deflection under the weight of the forms, the plastic concrete and reinforcement to 1/180 of the form span or 1/2" whichever is less; however, do not design for a total loading less than 120 pounds per square foot.

(d) Base the permissible form camber on the actual dead load condition. Do not use camber to compensate for deflection in excess of the foregoing limits.

(e) The design span of the form sheets is the clear distance between edges of beam or girder flanges minus 2 " measured parallel to the form flutes. Design and provide form sheets with a length at least the design span of the forms.

(f) Compute physical design properties in accordance with requirements of the American Iron and Steel Institute “Specification for the Design of Cold-Formed Steel Structural Members” latest published edition.

(g) Provide a minimum concrete cover of 1 1/4" clear above metal stay-in-place form to the bottom mat of reinforcement.

(h) Maintain the plan dimensions of both layers of primary deck reinforcement from the top of the concrete deck.

(i) Do not weld to flanges in tension or to structural steel bridge elements fabricated from non-weldable grades of steel.

(j) Weld metal stay-in-place forms for prestressed concrete girders to embedded clips in the girder flanges. The embedded clips shall be a minimum of 2” x 3” and 2” long. The clips shall be galvanized, 12 gauge ASTM A653 steel and have a ¾” or 1” diameter hole in the 2” leg. The spacing of the clips shall be 12”. All submitted metal stay-in-place form designs shall be able to utilize the standard size and spacing of the clip described above.

Do not unload or handle fabricated metal stay-in-place forming materials in such a manner as to damage or alter the configuration of the forms. Replace damaged materials at no additional cost to the Department.

Store fabricated metal stay-in-place forms that are stored at the project site at least 4" above the ground on platforms, skids or other suitable supports and protect against corrosion and damage from any source.

Install all forms in accordance with detailed fabrication plans submitted to the Engineer for review. Clearly indicate on the fabrication plans the locations where the forms are supported by steel beam flanges subject to tensile stresses. Do not weld to the flanges within these locations. Do not allow form sheets to rest directly on the top of the beam or girder. Securely fasten sheets to form supports with a minimum bearing length of 1" at each end. Center sheets between the form supports. Place form supports in direct contact with the flange of girder or beam. Make all attachments by permissible welds, bolts, clips or other approved means. Weld in accordance with Article 1072-20 of the *Standard Specifications*, except 1/8" fillet welds are permitted.

In the areas where the form sheets lap, securely fasten the form sheets to one another by screws at a maximum spacing of 18". Securely attach the ends of the form sheets to support angles with screws at a maximum spacing of 18".

Where the galvanized coating is damaged on any exposed form metal, thoroughly clean, wire brush, then paint with two coats of zinc oxide zinc dust primer, Federal Specification TT-P-64ld, Type II, no color added, to the satisfaction of the Engineer. Minor heat discoloration in areas of welds is not considered damage and does not require the above repair.

Locate transverse construction joints at the bottom of a flute and field drill 1/4" weep holes at not more than 12" on center along the line of the joint.

Use a saw for all cuts. Do not flame cut forms.

(E) Falsework and Forms Over or Adjacent to Traffic

In addition to the applicable sections in 420-3(A) through 420-3(D), the following requirements apply to falsework and forms including metal stay-in-place forms and precast concrete deck panels erected over vehicular, pedestrian or railroad traffic, or vessel traffic on navigable waterways. It also covers falsework and forms for those parts of a substructure unit constructed within 20 ft. of the edge of a travelway or railroad track and more than 25 ft. above the ground line at the time of substructure construction.

(1) Submittals

Submit detailed drawings as required by the contract and one set of design calculations for falsework and forms for review and acceptance before beginning construction of the falsework or forms. Have the drawings and

design calculations prepared, signed and sealed by a North Carolina Licensed Professional Engineer. These submittal requirements apply to all falsework and form systems covered by this section.

(2) Design

Design falsework and forms for the combined effects of dead load and live load and with appropriate safety factors in accordance with this section and the respective design codes of the materials used. Include the weight of concrete, reinforcing steel, forms and falsework in the dead load. Live load includes the actual weight of any equipment the falsework supports, applied as concentrated loads at the points of contact, and a uniform load of not less than 20 lbs/ft2 applied over the supported area. In addition, apply a line load of 75 lbs/ft along the outside edge of deck overhangs.

(3) Inspection

Before the form or falsework system is loaded, inspect the erected falsework and forms and submit a written statement certifying that the erected falsework system complies with the accepted detailed drawings prepared by the Licensed Professional Engineer. Submit a separate certification for each span, unit, or bridge component. Any condition that does not comply with the accepted drawings, or any other condition deemed unsatisfactory by the Engineer, is cause for rejection until corrections are made.

420-4 PLACING CONCRETE

Do not place concrete until the depth of the excavation, character of the foundation material, adequacy of the forms and falsework, placement of reinforcement and other embedded items are inspected and approved. Do not place concrete without an Inspector present.

Place concrete in daylight or obtain approval for an adequate lighting system for construction and inspection of the work.

In preparation for the placing of concrete, remove all sawdust, chips, and other construction debris and extraneous matter from the interior of forms. Remove hardened concrete and foreign matter from tools, screeds, and conveying equipment.

Make sure that the concrete temperature at the time of placing in the forms is not less than 50° F nor more than 95° F, except where other temperatures are required by Articles 420-7, and 420-14.

Do not use concrete that does not reach its final position in the forms within the time stipulated in Subarticle 1000-4(E).

Thoroughly clean and wet surfaces, other than foundation surfaces, immediately before placing concrete to facilitate bonding to those surfaces.

Regulate the placement of concrete so that the pressures caused by the wet concrete do not exceed those used in the design of the forms.

Thoroughly work the external surface of all concrete during the placing by means of approved tools. During the placing of concrete, take care to use methods of compaction that result in a surface of even texture free from voids, water, or air pockets, and that force the coarse aggregate away from the forms in order to leave a mortar surface.

Place concrete so as to avoid segregation of the materials and the displacement of the reinforcement.

Equip chutes on steep slopes with baffle boards or provide chutes in short lengths that reverse the direction of movement.

Use all chutes, troughs, and pipes made from suitable materials other than aluminum and keep them clean and free from coating of hardened concrete by thoroughly flushing with water after each run. Discharge the water used for flushing clear of the structure.

Confine concrete dropped more than 5 feet by closed chutes or pipes, except in walls of box culverts or retaining walls unless otherwise directed.

Take care to fill each part of the form by depositing the concrete as near to its final position as possible. Work the coarse aggregate back from the forms and around the reinforcement without displacing the bars. After initial set of the concrete, do not jar the forms and do not place strain on the projecting reinforcement or other items embedded in the concrete.

Compact all concrete required to be vibrated by means of approved high frequency internal vibrators or other approved type of vibrators immediately after depositing concrete in the forms. In all cases, have available at least 2 vibrators in good operating condition and 2 sources of power at the site of any structure in which more than 25 cubic yards of concrete is required. Do not attach or hold the vibrators against the forms or the reinforcing steel. When vibrating concrete containing epoxy coated reinforcing steel, use a vibrator with a protective rubber head as approved by the Engineer. Vibrate with care and in such a manner to avoid displacement of reinforcement, ducts, or other embedded elements. Vibrate in the appropriate location, manner, and duration to secure maximum consolidation of the concrete without causing segregation of the mortar and coarse aggregate, and without causing water to flush to the surface. When placing concrete to a depth in excess of 12" and containing one or more horizontal layers of reinforcing steel, place the concrete in horizontal layers not more than 12" thick. Place and compact each layer before the preceding layer takes initial set such that there is no surface of separation between layers. Do not taper layers of concrete in wedge-shaped slopes but instead place them with reasonably square ends and level tops.

If placing additional concrete against hardened concrete, take care to remove all laitance and to roughen the surfaces of the concrete to ensure that fresh concrete is deposited upon sound concrete surfaces and an acceptable bond is obtained. Thoroughly wet the existing concrete for a minimum of 2 hours before placing additional concrete.

Deposit and compact so as to form a compact, dense, impervious concrete of uniform texture which shows smooth faces on exposed surfaces. Repair, remove, and replace in whole or in part as directed and at no additional cost to the Department, any section of concrete found to be porous, cracked, plastered, or otherwise defective.

Protect beams and girders during concreting operations. Remove any concrete that gets on beams or girders immediately by an approved method to restore the surface to the specified condition.

420-5 PUMPING CONCRETE

Placement of concrete by pumping is permitted only when approved. Use and locate suitable pumping equipment that is adequate in capacity for the work and so that no vibrations result which might damage freshly placed concrete. Do not use pumping equipment, including the conduit system, which contains any aluminum or aluminum alloy that comes in contact with the concrete.

Waste all grout used to lubricate the inner surfaces of the conduit system.

Pump so that a continuous stream of concrete without air pockets is delivered.For test purposes, take concrete from the discharge end of the pump.

420-6 SLUMP TESTS

The slump of the concrete is determined in accordance with AASHTO T119.

When a slump test is made and the results of the test exceed the specified maximum, a check test is made immediately from the same batch or truck load of concrete. If the average of the 2 test results exceeds the specified maximum slump, the batch or truck load that contains the batch is rejected.

420-7 PLACING CONCRETE IN COLD WEATHER

(A) General

Do not place concrete when the air temperature, measured at the location of the concreting operation in the shade away from artificial heat, is below 35°F without permission. When such permission is granted, uniformly heat the aggregates and/or water to a temperature not higher than 150°F. Place the concrete when the temperature of the heated concrete is not less than 55°F and not more than 80°F.

Use aggregates that are free of ice, frost, and frozen particles. Do not place concrete on frozen foundation material.

Protect all concrete by means of heated enclosures or by insulation whenever any of the following conditions occur:

(a) The concrete is placed when the air temperature, measured at the location of the concreting operation in the shade away from artificial heat, is below 35°F.

(b) The air temperature, measured at the location of the freshly placed concrete in the shade away from artificial heat, is below 35°F and the concrete has not yet attained an age of 72 hours or an age of 48 hours when using high-early strength portland cement concrete. If the mix contains fly ash or ground granulated blast furnace slag, protect the concrete for 7 days.

Provide and place at directed locations a sufficient number of maximum-minimum recording thermometers to provide an accurate record of the temperature surrounding the concrete during the entire protection period.

Assume all risks connected with the placing of concrete under the cold weather conditions referred to herein. Permission given to place concrete when the temperature is below 35°F and the subsequent protection of the concrete as required herein does not relieve the Contractor in any way of the responsibility for obtaining the required results.

(B) Heated Enclosures

Immediately enclose portland cement concrete that is placed when the air temperature is below 35°F, and portland cement concrete that has not yet attained an age of 72 hours before the air temperature falls below 35°F, with a housing consisting of canvas or other approved material supported by an open framework or with an equally satisfactory housing. Maintain the air surrounding the concrete at a temperature of not less than 50°F nor more than 90°F for the remainder of the 72-hour period. Apply these same requirements to high-early-strength portland cement concrete except reduce the 72-hour period to 48 hours. Do not begin these time periods until completing manipulation of each separate mass of concrete.

Provide such heating apparatus as stoves, salamanders, or steam equipment, and the necessary fuel. When using dry heat, provide means of preventing loss of moisture from the concrete.

(C) Insulation

As an alternate to the heated enclosure specified in Subarticle 420-7(B), use insulated forms or insulation meeting all requirements of this subarticle to protect concrete. Use insulation under the same conditions that require heated enclosures. Place the insulation on the concrete as soon as initial set permits.

When using insulation for cold weather protection, batch concrete for sections 12" or less in thickness or diameter as outlined below. Use Type III portland cement without any increase in cement content, or use Type I or II portland cement with the cement content increased to 1.80 barrels per cubic yard. When the mix includes fly ash, use a mix containing 572 lbs. per cubic yard of cement and a minimum of 172 lbs. per cubic yard of fly ash. When the mix includes ground granulated blast furnace slag, use a mix containing 465 lbs. per cubic yard of cement and 250 lbs. per cubic yard of ground granulated blast furnace slag.

Use insulated materials with a minimum thickness of 1". Insulate overhang forms both on the outside vertical faces and on the underside with a 1" minimum thickness of either rigid or blanket type insulation. Use insulating materials which provide a minimum system R value of 4.0 in the up mode as determined by ASTM C-236 with a 15 mph wind over the cold side of the material and a minimum differential of 50°F. Furnish results of tests conducted in accordance with ASTM C-236 by an acceptable commercial testing laboratory for review, comments and acceptance. Obtain such acceptance prior to use of the material. Face or cover insulating blankets, top and bottom, with polyethylene or similar waterproofing material meeting the test requirements of Article 1026-3 except for the length and color requirements. Place blankets on the concrete in such a manner that they form a waterproof surface for the

protected concrete. Do not use blankets with rips and tears in the waterproofing material unless acceptably repaired. When the anticipated low temperature expected during the protection period is less than 10°F, provide 2" of insulation. Overlap blanket insulation mats at the edges by at least 6". Tightly butt rigid type insulation sheets together and seal. Take particular care to provide effective protection of curbs, corners, and around protruding reinforcing steel.

Should the air under the insulation fall below 50°F during the protection period, immediately cover the concrete with canvas and framework or other satisfactory housing and apply heat uniformly at a rate such that the air surrounding the concrete is not less than 50°F for the remainder of the protection period.

In the event that insulating materials are removed from the concrete prior to the expiration of the curing period, cure the concrete for the remainder of the period in accordance with Article 420-15.

420-8 CONSTRUCTION JOINTS

Provide construction joints only where located on the plans or shown in the placing schedule, unless otherwise approved in writing.

Place the concrete in each integral part of the structure continuously. Do not commence work on any such part unless the concrete supply, forces, and equipment are sufficient to complete the part without interruption in the placing of the concrete.

In case of emergency, make construction joints or remove the concrete as directed.

Make construction joints without keys, except when required on the plans. Rough float surfaces of fresh concrete at horizontal construction joints sufficiently to thoroughly consolidate the concrete at the surface.

After placing concrete to the construction joint and before placing fresh concrete, thoroughly clean the entire surface of horizontal construction joints of surface laitance, curing compound, and other materials foreign to the concrete. Clean vertical construction joints of curing compound and other materials foreign to the concrete.

Thoroughly clean and wet concrete surfaces for a minimum of 2 hours before placing additional concrete in order to facilitate bonding.

420-9 WIDENING EXISTING STRUCTURES

Where plans call for widening existing concrete structures, or otherwise require bonding new concrete to old, remove portions of the existing structures as indicated on the plans.

When extending an existing culvert, remove the following portions of the existing culvert: the portions that interfere with the proposed extension, headwalls only as necessary to clear proposed subgrade by a minimum of 18", and wingwalls in such a manner that square surfaces the full thickness of the new sidewalls are provided for bonding new concrete to old. Cut existing wingwall reinforcing steel off flush with the concrete surface.

Thoroughly roughen, clean of loose material, and wet connecting surfaces of the old concrete for a minimum of 2 hours before placing new concrete.

420-10 EXPANSION JOINTS

(A) General

Locate and construct all joints as shown on the plans.

Chamfer or edge the edges of joints as shown on the plans or as directed.

Immediately after removing the forms, inspect the expansion joint carefully. Neatly remove any concrete or mortar in the joint.

(B) Filled Joints

Use cork, bituminous fiber, neoprene, or rubber meeting the requirements of Article 1028-1 in all expansion joint material. Use an optional second layer to obtain the required thickness, when a thickness of more than 1" is required.

Cut the joint filler to the same shape and size as the area to be covered except cut it 1/2" below any surface that is exposed to view in the finished work. As an option, cut the joint filler the same size and shape as that of the adjoining surfaces, and neatly cut back the material 1/2" on the surfaces that are exposed to view after the concrete hardens. Cut the joint filler out of as few pieces as practicable and, except as noted above, completely fill the space provided. Fasten the pieces in any one joint together in an approved manner. Do not use loose fitting or open joints between sections of filler or between filler and forms. Do not use joints made up with small strips. Place two-ply roofing felt over all joints in the filler material in vertical expansion joints below top of curbs. Place the felt on the side of the joint adjacent to the new pour.

Seal all expansion joints with a low modulus silicone sealant in accordance with Article 1028-4.

420-11 DRAINS IN WALLS AND CULVERTS

Construct drain holes and weep holes in abutment walls, wing walls, retaining walls, and the exterior walls of culverts as shown on the plans unless otherwise directed, and backfill in accordance with the requirements of Articles 410-8 and 410-9.

Cover drain holes and weep holes at the back face of the wall with hardware cloth of commercial quality, approximately No. 4 mesh, of aluminum or galvanized steel wire.

420-12 ANCHOR BOLTS AND BEARING AREAS

(A) Anchor Bolts

Accurately set all necessary anchor bolts in piers, abutments, or pedestals either while placing concrete, in formed holes, or in holes cored or drilled after the concrete sets.

If set in the concrete, position the bolts by means of templates and rigidly hold in position while placing the concrete.

Form holes by inserting in the fresh concrete oiled wooden plugs, metal pipe sleeves, or other approved devices, and withdrawing them after the concrete partially sets. Provide holes formed in this manner that are at least 4" in diameter.

Core holes at least 1" larger in diameter than the bolt used. Use approved equipment for coring concrete. Do not use impact tools. Place reinforcing steel to provide adequate space to core bolt holes without cutting the reinforcing steel.

During freezing conditions, protect anchor bolt holes from water accumulation at all times.

Bond the anchors with a non-shrink portland cement grout or a grout made with epoxy resin. Completely fill the holes with grout. Use any pre-approved non-shrink composition compatible with the concrete.

(B) Bearing Areas

Finish bridge seat bearing areas to a true level plane to not vary perceptibly from a straightedge placed in any direction across the area.

Place bearing plates in accordance with the requirements of Article 440-4.

420-13 ADHESIVELY ANCHORED ANCHOR BOLTS OR DOWELS

(A) Description

The work covered by this section consists of furnishing all necessary labor, equipment, and materials and performing all operations necessary for installing anchor bolts/dowels in concrete using an adhesive bonding system in accordance with the details shown on the plans and with the requirements of Section 1082 unless otherwise directed.

Submit a description of the proposed adhesive bonding system to the Engineer for review, comments and acceptance. Include in the description the bolt type and its deformations, equipment, manufacturer's recommended hole diameter, embedment depth, material specifications, and any other material, equipment or procedure not covered by the contract. List the properties of the adhesive, including density, minimum and maximum temperature application, setting time, shelf life, pot life, shear strength and compressive strength. If bars/dowels containing a corrosion protective coating are required, provide an adhesive that does not contain any chemical elements that are detrimental to the coating and include a statement to this effect in the submittal concerning the contents as required by State or Federal Laws and Regulations.

(B) Procedure

(1) Drilling of Holes into Concrete

When directed, use a jig or fixture to ensure the holes are positioned and aligned correctly during the drilling process. Upon approval, adjusting hole locations to avoid reinforcing steel is permitted.

Drill the holes with a pneumatic drill unless another drilling method is approved. Follow the manufacturer's recommendations regarding the diameter of the drilled hole.

Immediately after completion of drilling, blow all dust and debris out of the holes with oil-free compressed air using a wand extending to the bottom of the hole. Remove all dust from the sides of the holes by brushing the holes with a stiff-bristled brush of a sufficient size and then blow the hole free of dust. Repeat this procedure until the hole is completely clean. Check each hole with a depth gauge to ensure proper embedment depth.

Repair spalled or otherwise damaged concrete using approved methods.

(2) Inspection of Holes

Inspect each hole immediately prior to placing the adhesive and the anchor bolts/dowels. Ensure all holes are dry and free of dust, dirt, oil, and grease. Rework any hole that does not meet the requirements of the contract.

(3) Mixing of Adhesive

Mix the adhesive in strict conformance with the manufacturer's instructions.

(4) Embedment of Anchor Bolt/Dowel

Clean each anchor bolt/dowel so that it is free of all rust, grease, oil, and other contaminants.

Unless otherwise shown on the plans, the minimum anchor bolt/dowel embedment depth is such that the adhesive develops at least 125% of the anchor bolt/dowel yield load as determined by the manufacturer.

Insert the anchor bolt/dowel the specified depth into the hole and slightly agitate it to ensure wetting and complete encapsulation. After insertion of the anchor bolt/dowel, strike off any excessive adhesive flush with the concrete face. Should the adhesive fail to fill the hole, add additional adhesive to the hole to allow a flush strike-off. Do not disturb the anchor bolts/dowels while adhesive is hardening.

(C) Field Testing

When specified on the plans, test the installed anchor bolts/dowels for adequate adhesive as specified below. Inform the Engineer when the tests will be performed at least 2 days prior to testing. Conduct the tests in the presence of the Engineer.

Use a calibrated hydraulic centerhole jack system for testing. Place the jack on a plate washer that has a hole at least 1/8" larger than the hole drilled into the concrete. Position the plate washer on center to allow an unobstructed pull. Position the anchor bolts/dowels and the jack on the same axis. Have an approved testing agency calibrate the jack within 6 months prior to testing. Supply the Engineer with a certificate of calibration.

In the presence of the Engineer, field test 10% of the first 50 anchor bolts/dowels prior to installing any additional anchors. For testing, apply and hold briefly 90% of the anchor bolt/dowel yield load shown on the plans. No visible signs of movement of the anchor bolts/dowels is permitted under this load. Upon receiving satisfactory results from these tests, install the remaining anchors. Test a minimum of 2% of the remaining anchors as previously described.

Record data for each anchor bolt/dowel tested on the report form entitled Installation Test Report of Adhesively Anchored Anchor Bolts or Dowels. Obtain this form from the North Carolina Department of Transportation Materials and Tests Engineer. Submit a copy of the completed report forms to the Engineer.

Final acceptance of the adhesively anchored system is based on the conformance of the pull test to the requirements of this specification. Failure to meet the criteria of this specification is grounds for rejection.

420-14 PLACING AND FINISHING BRIDGE DECKS

(A) Placing Concrete

Unless otherwise noted on the plans, use Class AA cast-in-place concrete conforming to the requirements of Section 1000.

When noted on the plans, use sand lightweight concrete conforming to the requirements of Section 1000.

Place concrete in accordance with these Specifications. Properly vibrate concrete to avoid honeycomb and voids. Have pouring sequences, procedures and mixes approved by the Engineer.

For metal stay-in-place forms, do not place concrete on the forms to a depth greater than 12" above the top of the forms. Do not drop concrete more than 3 feet above the top of the forms, beams or girder. Keep the top surface of prestressed concrete panels clean. Thoroughly inspect panels prior to placement of the concrete cast-in-place slab. Remove any foreign matter, oil, grease or other contaminants either with a high pressure water blast or sand blast. Saturate the top surface of the prestressed concrete panels by thoroughly wetting the top surface with water for a minimum of 2 hours before placing the cast-in-place concrete slab. Do not allow the wetted panel surface to dry before cast-in-place concrete slab placement. Remove all puddles and ponds of water from the surface of the panels and top of girder flanges before placing the cast-in-place concrete slab.

Obtain a smooth riding surface of uniform texture, true to the required grade and cross section, on all bridge decks.

Do not place bridge deck concrete until the Engineer is satisfied that adequate personnel and equipment are present to deliver, place, spread, finish, and cure the concrete within the scheduled time; that experienced finishing machine operators and concrete finishers are employed to finish the deck; and that weather protective equipment and all necessary finishing tools and equipment are on hand at the site of the work and in satisfactory condition for use. During the period between April 15 and October 15, begin placing the bridge deck concrete as early as practical to allow the work to be accomplished during the cooler hours when forms, beams, and reinforcing steel are at ambient air temperatures.

Unless otherwise permitted, set the rate of concrete placement and use a set retarder such that the concrete remains workable until the entire operation of placing, screeding, rescreeding, surface testing, and corrective measures where necessary are

complete. Use of a set retarder is waived when conditions clearly indicate it is not needed.

Place concrete in the deck when the concrete temperature at the time of placement is not less than 50°F, nor more than 90°F, except where other temperatures are required by Article 420-7.

Place concrete at a minimum rate of 35 cubic yards per hour.

Place and firmly secure supports for screeds or finishing machines before beginning placement of concrete. Set supports to elevations necessary to obtain a bridge roadway floor true to the required grade and cross section, and make allowance for anticipated settlement. Use supports of a type that upon installation, no springing or deflection occurs under the weight of the finishing equipment. Locate the supports such that finishing equipment operates without interruption over the entire bridge deck.

Immediately prior to placing bridge deck concrete, check all falsework and make all necessary adjustments. Provide suitable means such as telltales to permit ready measurement by the Engineer of deflection as it occurs. Do not adjust the profile grade-line for any of the forming types used, unless permitted.

On continuous steel beam or girder spans, cast the concrete in the order shown on the plans. Place concrete in a continuous manner between headers. Use approved screeds, screed supports, and screeding methods.

(B) Finishing

Unless otherwise specified or permitted, use mechanically operated longitudinal or transverse screeds for finishing bridge deckconcrete. Do not use vibratory screeds unless specifically approved. Use readily adjustable screeds with sufficient rigidity and width to strike-off the concrete surface at the required grade. Do not use aluminum strike-off elements of screeds and hand tools used for finishing concrete.

Furnish personnel and equipment necessary to verify the screed adjustment and operation prior to beginning concrete placement.

Unless otherwise permitted, do not use longitudinal screeds for pours greater than 85 feet in length. Place sufficient concrete ahead of the screeded area to assure all dead load deflection occurs before final screeding.

When using a transverse screed on a span with a skew angle less than 75 degrees or more than 105 degrees, orient and operate the truss or beam supporting the strike-off mechanism parallel to the skew. Position the strike-off parallel to the centerline of bridge, and make the leading edge of concrete placement parallel to the skew. If approved, operate at a reduced skew angle on very wide or heavily skewed spans where the distance between screed supports exceeds 100 feet.

Orient and operate transverse screeds used on spans with skew angles between 75 degrees and 105 degrees parallel to the skew or perpendicular to the centerline of bridge.

Prior to placing concrete, verify the adjustment and operation of the screed as directed by operating the screed over the entire area and across all end bulkheads. Check the floor thickness and cover over reinforcing steel shown on the plans, and make adjustments as necessary.

During the screeding operation, keep an adequate supply of concrete ahead of the screed and maintain a slight excess immediately in front of the screed. Operate the screed to obtain a substantially uniform surface finish over the entire bridge deck. Do not allow workmen to walk on the concrete after screeding. Use a minimum of 2 approved work bridges to provide adequate access to the work for the purpose of finishing, testing, straightedging, making corrections, fogging, applying curing medium, and for other operations requiring access to the bridge deck Support the work bridges outside the limits of concrete placement.

The Engineer makes random depth checks of deckthickness and cover over reinforcing steel over the entire placement area and directly behind the screed in the fresh concrete. If depth checks indicate variations from plan dimensions in excess of 1/2", take corrective action immediately.

Immediately following the screed and while the concrete is still workable, test the floor surface for irregularities with a 10-foot straightedge. Test by holding the straightedge in successive positions parallel to the centerline of bridge and in contact with the floor surface. Test the surface approximately 18" from the curb line, at the centerline of each lane, and at the centerline of 2 lane bridges. Advance along the bridge in stages of not more than 1/2 the length of straightedge. Test the surface transversely at the ends, quarter points, and center of the span as well as other locations as directed.

Immediately correct areas showing depressions or high spots of more than 1/8" in 10 feet by filling depressions with fresh concrete or by striking off high spots. Make corrections with hand tools or a combination of hand tools and rescreeding. Do not use the straightedge as a finishing tool. Give surfaces adjacent to expansion joints special attention to assure they meet the required smoothness.

Provide on the site fogging equipment which is capable of applying water to the concrete in the form of a fine fog mist in sufficient quantity to curb the effects of rapid evaporation of mixing water from the concrete on the bridge deck resulting from wind, high temperature, or low humidity, or a combination of these factors. Do not apply the moisture from the nozzle under pressure directly upon the concrete and do not allow it to accumulate on the surface in a quantity sufficient to cause a flow or wash the surface. Maintain responsibility for determining when to apply the fog mist; however, also apply it when directed.

Keep readily available on site an adequate supply of suitable coverings that will protect the surface of the freshly placed bridge deck from rain. After the water sheen disappears from the surface and before the concrete becomes non-plastic, finish the surface of the floor further by burlap dragging, fine bristle brooming, belting, or other acceptable method which produces an acceptable uniform texture.

Do not use membrane curing compound unless approved. Cure the concrete using the water method in accordance with Article 420-15(B), with the following exceptions. Prior to reaching initial set, place a curing medium consisting of burlap under polyethylene sheets or another approved material on the deck and keep moist for a minimum of 7 curing days. Wet the burlap or other approved curing medium prior to placing on the deck. Apply water to the curing medium through soaker hoses or another approved method. Apply water in amounts to keep the medium moist but do not allow the water to flow or pond on the deck.

After curing the concrete, test the finished surface by means of an approved rolling straightedge designed, constructed, and adjusted to accurately indicate or mark all floor areas which deviate from a plane surface by more than 1/8" in 10 feet. Remove all high areas in the hardened surface in excess of 1/8" in 10 feet with an approved grinding or cutting machine. Where variations are such that the corrections will extend below the limits of the top layer of grout, seal the corrected surface with an approved sealing agent as required. If approved, correct low areas in an acceptable manner. Produce corrected areas that have a rough, uniform texture and present neat patterns. In all cases, maintain a minimum of 2" of concrete cover over reinforcement.

Unless otherwise indicated on the plans, groove bridge decks Produce grooves that are perpendicular to the centerline of bridge. Do not start grooving until final straightedging and, when necessary, acceptable corrective measures are complete. Cut grooves into the hardened concrete using a mechanical saw device, which leaves rectangular grooves 1/8" wide and 3/16" deep. Produce grooves that have a center to center spacing of 3/4". Do not groove the deck surface within 18" of the gutter lines and 2" of expansion joints or elastomeric concrete in expansion joint blockouts. On skewed bridges, ungrooved triangular areas adjacent to the joint are permitted, provided the distance from the centerline joint to the nearest groove, as measured parallel to the centerline of roadway, does not exceed 18". Between expansion joints on horizontally curved bridges, periodically adjust the grooving operation such that adjacent grooves are separated by no more than 3" along the outer radius of the bridgedeck.

Continuously remove all slurry or other residue resulting from the grooving operation from the bridge deck by vacuum pick-up or other approved methods. Prevent slurry from flowing into deck drains or onto the ground or body of water under the bridge. Dispose of all residue off the project.

(C) Inspection

The Engineer observes all phases of the construction of the bridge deck slab. These phases include installation of the metal forms; location and fastening of the reinforcement; composition of concrete items; mixing procedures, concrete placement and vibration; and finishing of the bridge deck.

After the deck concrete is in place for a minimum period of 2 days, test the concrete for soundness and bonding of the metal stay-in-place forms by sounding with a hammer as directed. For a minimum of 50% of the individual form panels, as

selected by the Engineer, hammer test over the entire area of the panel. If areas of doubtful soundness are disclosed by this procedure, remove the forms from such areas for visual inspection after the pour attains a minimum compressive strength of 2400 psi. Remove the stay-in-place forms at no additional cost to the Department.

At locations where sections of the forms are removed, do not replace the forms, but repair the adjacent metal forms and supports to present a neat appearance and assure their satisfactory retention. As soon as the forms are removed, allow the Engineer to examine for cavities, honeycombing and other defects. If irregularities are found, and in the opinion of the Engineer these irregularities do not justify rejection of the work, repair the concrete as directed. If the concrete where the forms are removed is unsatisfactory, remove additional forms, as necessary, to inspect and repair the slab. Modify the methods of construction as required to obtain satisfactory concrete in the slabs. Remove and repair all unsatisfactory concrete as directed.

Provide all facilities as are reasonably required for the safe and convenient conduct of the Engineer's inspection procedures.

420-15 CURING CONCRETE

(A) General

Unless otherwise specified in the contract, use any of the following methods except for membrane curing compounds on bridge deck unless permitted in conjunction with the polyethylene sheeting method or on concrete which is to receive epoxy protective coating in accordance with 420-18. Advise the Engineer in advance of the proposed method. Have all material, equipment, and labor necessary to promptly apply the curing on the site before placing any concrete. Cure all patches in accordance with this article. Improperly cured concrete is considered defective.

When used in this article, curing temperature is defined as the atmospheric temperature taken in the shade away from artificial heat, with the exception that it is the temperature surrounding the concrete where the concrete is protected in accordance with Article 420-7.

A curing day is defined as any consecutive 24-hour period, beginning when the manipulation of each separate mass is complete, during which the air temperature adjacent to the mass does not fall below 40°F.

After placing the concrete, cure it for a period of 7 full curing days.

Take all reasonable precautions to prevent plastic shrinkage cracking of the concrete, including the provision of wind screens, fogging, application of an approved temporary liquid moisture barrier, or the early application of temporary wet coverings to minimize moisture loss.

Repair, remove, or replace as directed concrete containing plastic shrinkage cracks at no cost to the Department.

(B) Water Method

Keep the concrete continuously wet by the application of water for a minimum period of 7 curing days after placing the concrete.

When using cotton mats, rugs, carpets, or earth or sand blankets to retain the moisture, keep the entire surface of the concrete damp by applying water with a nozzle that so atomizes the flow that a mist and not a spray is formed, until the surface of the concrete is covered with the curing medium. Do not apply the moisture from the nozzle under pressure directly upon the concrete and do not allow it to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface. At the expiration of the curing period, clear the concrete surfaces of all curing mediums.

(C) Membrane Curing Compound Method

Spray the entire surface of the concrete uniformly with a wax-free, resin-base curing compound conforming to the requirements of Article 1026-2. Use clear curing compound to which a fugitive dye is added for color contrast on bridge superstructures and substructures, and on retaining walls. Use either white pigmented or clear curing compound on culverts.

Apply the membrane curing compound after the surface finishing is complete, and immediately after the free surface moisture disappears. During the finishing period, protect the concrete by applying water with the fogging equipment specified in Subarticle 420-15(B).

Seal the surface with a single uniform coating of the specified type of curing compound applied at the rate of coverage recommended by the manufacturer or as directed, but not less than 1 gallon per 150 square feet of area on surfaces other than bridge approach slabs. On bridge approach slabs, apply the curing compound at a minimum rate of 1 gallon per 100 square feet of area.

At the time of use, thoroughly mix the compound with the pigment uniformly dispersed throughout the vehicle. If the application of the compound does not result in satisfactory coverage, stop the method and begin water curing, as set out above, until the cause of the defective work is corrected.

At locations where the coating shows discontinuities, pinholes, or other defects, or if rain falls on the newly coated surface before the film dries sufficiently to resist damage, apply an additional coat of the compound at the same rate specified herein immediately after the rain stops.

Completely remove any curing compound adhering to a surface to which new concrete is to be bonded by sandblasting, steel wire brushes, bush hammers, or other approved means.

Protect the concrete surfaces to which the compound is applied from abrasion or other damage that results in perforation of the membrane film for 7 curing days after placing the concrete. If the film of membrane compound is damaged or removed before the expiration of 7 curing days, immediately cure the exposed concrete by the water method until the expiration of the 7 curing days or until applying additional curing compound.

In the event that the application of curing compound is delayed, immediately start applying water as provided in Subarticle 420-15(B) and continue until resuming or starting application of the compound.

(D) Polyethylene Sheeting Method

Wet the exposed finished surface of concrete with water, using a nozzle that so atomizes the flow to form a mist and not a spray, until the concrete sets, after which place the white opaque polyethylene sheeting. Continue curing for 7 curing days after the concrete is placed. If the sheeting is damaged or removed before the expiration of 7 curing days, immediately cure the exposed concrete by the water method until placing additional sheeting or until after 7 curing days.

Use sheeting which provides a complete continuous cover of the entire concrete surface. Lap the sheets a minimum of 12" and securely weigh down or cement them together in such a manner as to provide a waterproof joint.

If any portion of the sheets is broken or damaged before the expiration of the curing period, immediately repair the broken or damaged portions with new sheets properly secured in place.

Do not use sections of sheeting damaged to such an extent as to render them unfit for curing the concrete.

(E) Forms-in-Place Method

As an option, cure surfaces of concrete by retaining the forms in place for a minimum period of 7 curing days after placing the concrete.

If electing to leave forms in place for a part of the curing period and using one of the other methods of curing included in this article for the remainder of the curing period, keep the concrete surfaces wet during transition between curing methods.

420-16 REMOVAL OF FORMS AND FALSEWORK

Do not remove forms and falsework for the portions of structures listed in Table 420-1 until the concrete attains the compressive strength shown, as evidenced by nondestructive test methods approved in writing or by conducting compressive strength tests in accordance with AASHTO T22 and T23. Furnish approved equipment used for nondestructive tests.

TABLE 420-1
MINIMUM CONCRETE STRENGTH FOR
REMOVAL OF FORMS AND FALSEWORK

Portion of Structure	Minimum CompressiveStrength, psi
Bridge Deck Slabs and overhangs for beam and girder bridges	3,000
Arch culverts, top slabs of box culverts, walls of box culverts when cast monolithically with the top slab or when the wall is 10 feet or more in height, caps and struts of sub-Structures, diaphragms, and other members subject to dead load bending	2,400

Remove forms for ornamental work, railing, parapets, walls less than 10 feet in height, curb faces on bridge superstructures, and vertical surfaces that do not carry loads, any time after 3 hours if the concrete is set sufficiently to permit form removal without damage to the member.

Do not remove forms used for insulation before the expiration of the minimum protective period required in Article 420-7.

Do not remove formwork for bent diaphragms until after casting deck concrete and allowing the concrete to attain a strength of 2,400 psi. As an option, to remove support from bent diaphragms prior to casting deck concrete, submit for approval a method to prevent the possibility of bent diaphragms slipping downward.

When removing forms prior to the end of the required curing period, use other curing methods to complete the required curing. When removing forms from underneath slabs prior to the end of the curing period, complete the curing in accordance with the requirements of Subarticle 420-15(C).

420-17 SURFACE FINISH

(A) General

Finish all concrete as required by this article except for bridge decks. Use the type of finish called for in Subarticles 420-17(B) through 420-17(D), except where the contract requires a Class 1 or Class 2 surface finish. Apply epoxy protective coating as required by 420-18.

(B) Ordinary Surface Finish

Apply ordinary surface finish to all formed concrete surfaces either as a final finish or preparatory to a higher class finish. On surfaces backfilled or otherwise covered, or enclosed surfaces, the removal of fins and form marks, the rubbing of grouted areas to a uniform color, and the removal of stains and discoloration, is not required. Use an ordinary surface finish, unless otherwise required, as final finish on all surfaces.

During the placing of concrete, take care to use methods of compaction that result in a surface of even texture free from voids, water, or air pockets, and that the coarse aggregate is forced away from the forms in order to leave a mortar surface.

Immediately after removing the forms, clean and fill with grout all pockets, depressions, honeycombs and other defects as directed. Remove all form ties or metal spacers to a depth of at least 1" below the surface of the concrete then clean and fill the resulting holes or depressions with grout. As an option, break off flush with the concrete surface those metal devices with exposed cross sectional area not exceeding 0.05 square inches on surfaces permanently in contact with earth fill. Unless otherwise required, remove fins and other projections flush with the concrete surface. Remove stains and discoloration.

Use grout for patching which contains cement and fine aggregate from the same sources and in the same proportions as used in the concrete. Cure the grout in accordance with Article 420-15. After the grout has thoroughly hardened, rub the surface with a carborundum stone as required to match the texture and color of the adjacent concrete.

(C) Unformed Surfaces Not Subjected to Wear

Finish all unformed surfaces not subjected to wear by placing an excess of material in the forms and removing or striking off such excess with a wooden template, forcing the coarse aggregate below the mortar surface. Do not use mortar topping for concrete railing caps and other surfaces falling under this classification.

Obtain the final finish for caps and railing in one of the following ways:

(1) Brush Finish: After striking off the concrete as described above, have skilled and experienced concrete finishers thoroughly work and float the surface with a wooden, canvas, or cork float. Before this last finish sets, lightly stroke the surface with a fine brush to remove the surface cement film, leaving a fine grained, smooth, but sanded texture.

(2) Float Finish: Finish the surface with a rough carpet float or other suitable device leaving the surface even, but distinctly sandy or pebbled in texture.

(D) Sidewalk, Islands, or Stairways on Bridges

Strike off and compact fresh concrete until a layer of mortar is brought to the surface. Finish the surface to grade and cross section with a float, trowel smooth, and finish with a broom. If water is necessary, apply it to the surface immediately in advance of brooming. Broom transverse to the line of traffic.

(E) Class 1 Surface Finish

In addition to the requirements of Subarticle 420-18(B), as soon as the pointing sets sufficiently to permit, thoroughly wet the entire surface with a brush and rub with a coarse carborundum stone or other equally good abrasive, bringing the surface to a paste. Continue rubbing to remove all form marks and projections, producing a smooth dense surface without pits or irregularities.

Carefully spread or brush uniformly over the entire surface the material ground to a paste by rubbing and allowing it to take a reset. After rubbing, cure the surface for a period of 7 curing days. Obtain the final finish by thoroughly rubbing with a fine carborundum stone or other equally good abrasive. Continue this rubbing until the entire surface is of a smooth texture and uniform color.

(F) Class 2 Surface Finish

In addition to the requirements of Subarticle 420-17(B), after the pointing sets sufficiently to permit, thoroughly wet and rub the entire surface with a coarse carborundum stone or other equally good abrasive to bring the surface to a smooth texture and remove all form marks. Finish the paste formed by rubbing as described above by carefully stroking with a clean brush, or spread it uniformly over the surface and allow it to take a "reset", then finish it by floating with a canvas, carpet-faced, or cork float; or rub down with dry burlap.

420-18 EPOXY COATING

(A) General

Use an epoxy coating meeting the requirements of Section 1081, Type 4A Flexible and moisture insensitive. Provide a certification showing the proposed epoxy meets Type 4A requirements.

(B) Surfaces

With the exception of cored slab bridges, apply the epoxy protective coating to the top surface area, including chamfer area of bent caps under expansion joints and of end bent caps, excluding areas under elastomeric bearings. For cored slab bridges, do not apply the epoxy protective coating to the bent or end bent caps.

Use extreme care to keep the area under the elastomeric bearings free of the epoxy protective coating. Do not apply the epoxy protective coating in the notch at the ends of the prestressed concrete girders.

Thoroughly clean all dust, dirt, grease, oil, laitance and other objectionable material from the concrete surfaces to be coated. Air blast all surfaces immediately prior to applying the protective coating.

Use only cleaning agents preapproved by the Engineer.

(C) Application

Apply epoxy protective coating only when the air temperature is at least 40°F and rising, but less than 95°F and the surface temperature of the area to be coated is at least 40°F. Remove any excess or free standing water from the surfaces before

applying the coating. Apply one coat of epoxy protective coating at a rate such that it covers between 100 and 200 ft^2 /gal.

Under certain combinations of circumstances, the cured epoxy protective coating may develop an oily condition on the surface due to amine blush. This condition is not detrimental to the applied system.

Apply the coating so that the entire designated surface of the concrete is covered and all pores are filled. To provide a uniform appearance, use the exact same material on all visible surfaces.

420-19 PROTECTION OF SUBSTRUCTURE CONCRETE FROM RUST STAINS

In order to prevent unpainted structural steel from staining substructure concrete, protect all final exposed areas of the concrete from rust stains until casting the bridge deck and sealing the expansion joints. Use an approved method for protecting the concrete.

In lieu of the above, remove the stains by approved methods and cleaning agents.

420-20 PLACING LOAD ON STRUCTURE MEMBERS

Do not place beams or girders on concrete substructures until the concrete in the substructure develops a minimum compressive strength of 2,400 psi.

In addition to the requirements of Article 410-8, do not place backfill or fill for retaining walls, abutments, piers, wing walls, or other structures that will retain material to an elevation higher on one side than the other until the concrete develops the minimum specified strength for the class of concrete required for the structure.

Do not carry backfill for arch culverts and box culverts to an elevation higher than 1 foot above the top of footing or bottom slab until the concrete develops the minimum specified strength for the class of concrete required for the culvert.

Adhere to the following time and strength requirements for erection of forms and construction of superimposed bridge substructure elements:

(A) Wait a minimum of 12 hours between placing footing or drilled pier concrete and erecting column forms.

(B) Wait a minimum of 24 hours between placing footing or drilled pier concrete and placing column concrete.

(C) Wait a minimum of 72 hours between placing column concrete and beginning erection of cap forms or until column concrete attains a compressive strength of at least 1,500 psi.

(D) Wait a minimum of 96 hours between placing column concrete and placing cap concrete or until column concrete attains a compressive strength of at least 2,000 psi.

Do not place vehicles or construction equipment on a bridge deck until the deck concrete develops the minimum specified 28 day compressive strength and attains an age of at least 14 curing days. Construction equipment is allowed on bridge approach slabs after the slab

concrete develops a compressive strength of at least 3,000 psi and attains an age of at least 7 curing days. A curing day is defined in Subarticle 420-15(A).

Provide evidence that the minimum compressive strengths referred to above are satisfied by nondestructive test methods approved in writing or by compressive strength tests made in accordance with AASHTO T22 and T23. Furnish approved equipment for use in nondestructive tests.

Do not place construction equipment, materials, or other construction loads on any part of the structure without permission. Submit 7 copies of the proposed plans for placing construction loads on the structure for review, comments and acceptance.

Do not abruptly start or stop concrete trucks on bridge deck. Do not mix concrete in the truck while on the deck. While machine forming concrete barrier rail or parapet, do not place any equipment on the deck except one concrete truck and the equipment necessary to place the concrete. Allow concrete barrier rail and parapet to attain a compressive strength of 3000 psi prior to placing any traffic on the deck other than equipment referenced above necessary to construct any remaining barrier rail or parapet. Do not operate heavy equipment over any box culvert until properly backfilling with a minimum cover of 3 feet.

420-21 MEASUREMENT AND PAYMENT

Class _____Concrete will be measured and paid as the number of cubic yards of each class that is incorporated into the completed and accepted structure except as indicated below. The number of cubic yards of concrete is computed from the dimensions shown on the plans or from revised dimensions authorized by the Engineer. When the foundation material is rock, the number of cubic yards of footing concrete is computed by the average end area method using the lower limits established for foundation excavation. The volume of concrete displaced by piles other than steel piles is not included in the quantity to be paid for.

Grooving bridge floors will be measured and be paid as the actual number of square feet shown on the plans. Where the plans are revised, the quantity to be paid for is the quantity shown on the revised plans.

Reinforced Concrete Deck Slab and Reinforced Concrete Deck Slab (sand lightweight concrete) will be measured and paid as the number of square feet shown on the plans. No separate payment will be made for furnishing and incorporating calcium nitrite corrosion inhibitor when required by the plans.

The plan quantity is determined from the horizontal surface area using the nominal dimensions and configuration shown in the Layout Sketch for computing surface area as shown on the plans. The transverse dimension is out to out of slab including raised median and/or sidewalk sections. Diaphragms are considered as a portion of the slab. When required by the plans, curtain walls, raised medians, sidewalks, pavement brackets, end posts, sign mounts, luminaire brackets and any other concrete appurtenances, expansion joint material, etc. are also considered a part of this item. Concrete Barrier Rail (including curved end blocks for the concrete barrier rail, when used) is not considered a part of this item.

For structural steel spans, the quantities of concrete and reinforcing steel shown on the plans are based on a metal stay-in-place forming method. These quantities include amounts for 1" additional concrete due to the corrugation of the metal forms, concrete diaphragms and, when required by the plans, curtain walls, pavement brackets, end posts, raised medians, sidewalks and other required attachments based on the profile grade and plan camber of the girders.

For prestressed concrete girder spans, the quantities of concrete and reinforcing steel shown on the plans are based on the forming method detailed on the plans. These quantities include concrete diaphragms, and, when required by the plans, curtain walls, pavement brackets, end posts, raised medians, sidewalks, and other required attachments based on the profile grade and plan camber of girders. The quantities also include either cast-in-place slab concrete when the plans are detailed for the prestressed concrete panel forming method or amounts for 1" additional concrete due to the corrugation of the metal forms when the plans are detailed for the fabricated metal stay-in-place form forming method and based on the profile grade and plan camber of the girders.

No measurement is made for concrete or reinforcing steel due to a variation in camber of the girders from the plan camber or for additional quantities required by optional methods of forming.

No separate measurement or payment will be made for furnishing, installing, and testing anchor bolts/dowels. Payment at the contract unit prices for the various pay items will be full compensation for all materials, equipment, tools, labor, and incidentals necessary to complete the work.

These prices and payments will be full compensation for all items required to construct concrete structures.

Payment will be made under:

Pay Item	Pay Unit
Class _____Concrete	Cubic Yard
Grooving Bridge Floors	Square Foot
Reinforced Concrete Deck Slab	Square Foot
Reinforced Concrete Deck Slab (Sand Lightweight Concrete)	Square Foot

SECTION 422
BRIDGE APPROACH SLABS

422-1 DESCRIPTION

Construct reinforced concrete slabs at bridge approaches, including subgrade, base course, curbs and sidewalks; furnish and place temporary slope drainage systems and subsurface drainage systems; remove existing pavement or approach slab; furnish and place concrete, reinforcing steel, joint filler, sealer and other materials; finish and cure concrete.

Construct the approach slabs before constructing concrete barrier rails or sidewalks.

422-2 MATERIALS

Refer to Division 10:

Item	Section
Portland Cement Concrete	1000
Curing Agents	1026
Joint Filler	1028-1
Joint Sealer	1028-4
Reinforcing Steel	1070
Subdrain Fine Aggregate	1044-1
Stone, No. 78M	1005
Aggregate Base Course	1010-1 through 1010-4
Corrugated Aluminum Alloy Pipe	1032-2
Corrugated Steel Pipe	1032-3
Corrugated Polyethylene (PE) Pipe	1044-6

422-3 CONSTRUCTION METHODS

When weep drains are shown on the plans, place a stone drain consisting of 1 cubic foot of No. 78M stone contained in a porous fabric bag at each pipe drain located in the end bent cap or abutment and tie it securely. Place subdrain fine aggregate in conjunction with the stone drain as shown on the plans.

Place and compact the subdrain fine aggregate in accordance with Article 410-10.

Construct the subgrade in accordance with Section 500.

Construct the aggregate base course in accordance with Section 520.

Construct the asphalt concrete base course in accordance with Section 610.

Apply the requirements of Section 420 to all concrete except as otherwise provided herein. Use class AA concrete.

Finish and groove the reinforced concrete bridge approach slabs in accordance with the requirements of Article 420-14, except do not groove the approach slabs when grooving the bridge deck is not required.

When grooving is not required, apply a broomed texture to the approach slabs before the concrete becomes non-plastic. Cure bridge approach slabs in the same manner as specified for bridge decks in Article 420-15(B).

Temporarily cover or fill the opening in the joint at the end bent until installation of the joint seal. Make sure that the covering or filler provides for drainage off the bridge deck and keeps debris out of the joint and off the end bent cap.

Shape the concrete curb to match the face of the barrier rail. Do not place the curb within the limits shown on the plans until after sawing the joint at the end bent. Give the concrete a light broom finish with brush marks parallel to the curb.

When shown on the plans, construct sidewalks on bridge approach slabs in accordance with plan details. Do not construct sidewalks until sawing the joint at the end bent. Finish the concrete in accordance with Subarticle 420-17(D).

Include in the temporary slope drainage system the earth ditch block, erosion resistant surface material, Class B stone for erosion control, and the pipe. Locate it as shown on the plans.

Use either corrugated polyethylene (PE), corrugated steel, or corrugated aluminum alloy for the temporary drainage pipe. Do not use perforated pipe. Provide temporary pipe of sufficient length for complete drainage away from the roadway embankment.

Backfill the approach slabs as soon as practical to prevent erosion adjacent to the slab.

422-4 MEASUREMENT AND PAYMENT

The price and payment below will be full compensation for all items required to construct bridge approach slabs including but not limited to those items contained in Article 422-1.

Bridge Approach Slabs, Sta. _____ will be paid for at the contract lump sum price.

Grooving bridge approach slabs will be paid for at the contract unit price per square foot for Grooving Bridge Decks as provided in Article 420-21.

Payment will be made under:

Pay Item	Pay Unit
Bridge Approach Slabs, Sta. ____	Lump Sum

SECTION 425
FABRICATING AND PLACING REINFORCEMENT

425-1 DESCRIPTION

Furnish, fabricate, and place steel reinforcement other than wire mesh reinforcement, including all related materials such as tie wire, separators, wire bar supports, mechanical butt splices for reinforcing steel, and other material for fastening the reinforcing steel in place; galvanize and/or coat where required; and fabricate, cut, bend, place, and splice the reinforcement in conformity with the shape and dimensions shown on the plans and as specified in these Specifications. Provide epoxy coated reinforcing steel where indicated on the plans.

425-2 MATERIALS

Refer to Division 10:

Item	Section
Steel Bar Reinforcement	1070-2
Wire Mesh Reinforcement	1070-3
Reinforcing Wire	1070-3
Wire Bar Supports	1070-4
Epoxy Coated Reinforcing Steel	1070-8
Spiral Column Reinforcing Steel	1070-9
Epoxy Coated Spiral Column Reinforcing Steel	1070-9
Mechanical Butt Splices for Reinforcing Steel	1070-10

425-3 PROTECTION OF MATERIALS

Protect steel reinforcement at all times from damage and make sure it is free from dirt, dust, loose mill scale, loose rust, paint, oil, or other foreign materials at the time of placement in the work.

Store epoxy coated reinforcing steel bars at the project site a minimum of 1 foot above the ground on wooden or padded supports placed 10 feet apart, and completely cover with an opaque cloth, canvas, or woven fiber reinforced polyethylene white tarp. Do not use solid plastic sheeting. Cover the bars such that adequate ventilation is provided to prevent condensation from forming on the material during storage, and completely protect the bars from direct sunlight. Do not allow water to pond under the epoxy coated reinforcing steel.

Store epoxy coated bars as close as possible to their final location in the structure to prevent coating damage from unnecessary handling.

Do not store epoxy coated bars at the project site from one construction season until the following construction season unless stored in a waterproof enclosure.

425-4 PLACING AND FASTENING

Accurately place reinforcement as shown on the plans and secure firmly in position by wiring at intersections and using metal bar supports, precast mortar blocks, or other approved devices of sufficient strength and location to resist distortion.

Tie reinforcing bars at all intersections except where spacing is less than 1 foot in both the longitudinal and transverse directions, in which case tie at alternate intersections, as an option. Securely tie each intersection of vertical reinforcing steel and spiral reinforcement for drilled piers. Use plastic or epoxy coated spiral spacers with epoxy coated spiral column reinforcing steel.

Provide wire bar supports for reinforcing steel in accordance with Article 1070-4 of the proper height to provide the distance from the forms and the proper spacing between rows of steel as indicated on the plans. When required by the plans, epoxy coat bar supports in accordance with Article 1070-8. Provide rust-proofed supporting legs for wire bar supports that rest on the forms as provided in Article 1070-4. When providing rust proofing by

plastic protection, make sure that the dipped plastic coating or premolded plastic tips are intact on each bar support leg while concrete is placed.

Precast blocks, of approved shape and dimensions, for holding vertical reinforcement in position from 1:2 mortar or concrete of the same mix used in the member being cast. Cure precast blocks in accordance with the requirements of Article 420-15 for the water method or the polyethylene sheeting method. To hold vertical bars in position, use precast blocks which have embedded wires extending from the block a sufficient distance to tie to the bar.

Roll mesh reinforcement flat before placing concrete, unless otherwise shown on the plans. Hold mesh reinforcement firmly in place against vertical and transverse movement by acceptable means.

Weld reinforcing steel in accordance with the American Welding Society's "Reinforcing Steel Welding Code AWS D1.4" and only where required in the contract. Obtain written approval for additional welding. Do not use tack welds unless approved.

Exercise extreme care when transporting, handling, placing and tying epoxy coated reinforcing steel to prevent damage to the coating.

Immediately before placing epoxy coated reinforcing steel bars in the forms, visually inspect each bar for coating damage. Ensure that all coating damaged by any cause is satisfactorily repaired, including hairline cracks and that each bar, including bar ends, is completely encapsulated in epoxy coating or patching material at the time of concrete placement. Make coating repairs as described in Section 1070-8(K) with material specified in Section 1070-8(C). Do not coat more than 5 percent of surface area on each bar with patching material including patching due to damage to the coating by the coater, fabricator, transporter, or contractor. The patching limits do not include holiday repairs, overspray and coated ends of bars.

Do not expose epoxy coated reinforcing steel to the weather for more than 30 days after placing in the forms. If the concrete is not placed within 30 days, cover the epoxy coated reinforcing steel as required by Article 425-3.

Do not place reinforcement while placing concrete in the member involved.

Place, allow inspection, and obtain approval for reinforcement in any member before placing concrete.

425-5 SPLICING

(A) General

Furnish all reinforcement in the full lengths indicated on the plans.

Do not splice bars without written approval except where shown on the plans.

Provide splice lengths as shown on the plans.

Overlap sheets of mesh with each other sufficiently to maintain a uniform strength and securely fastened to each other at the ends and edges. Lap at least the dimension of 1 mesh.

(B) Mechanical Butt Splices

Provide mechanical butt slices for reinforcing steel in accordance with section 1070-10 when called for on the plans.

When an exothermic connector is used, do not let the splice depend upon fusion of the filler metal with the bars. Select a temperature for heating the bars that is below the melting point of the bars and is sufficiently low so as not to significantly affect the original hardness nor decrease the structural properties of the bars. Visual inspection of the finished splices is sufficient; the splice is acceptable if sound filler metal is present at both ends of the splice sleeve and at the sleeve entry port.

Splice the bars in accordance with the manufacturer's recommendations using the manufacturer's required accessories as approved by the Engineer. Use mechanical butt splices only where specified on the plans. Any additional splices require approval.

If bars are epoxy coated, strip the epoxy coating within the limits of the sleeve prior to splicing. After making the splice, paint any unprotected areas of the reinforcing bar and the coupling sleeve with epoxy paint as described in the *Standard Specifications.*

425-6 MEASUREMENT AND PAYMENT

Reinforcing Steel or *Epoxy Coated Reinforcing Steel* will be measured and paid for as the number of pounds of steel bar reinforcement, reinforcing wire, and plain rods shown on the plans as being necessary to complete the work. Where the plans are revised, the quantity to be paid for is the quantity shown on the revised plans. Where directed to deviate from the plans in such a manner to change the quantities of steel bar reinforcement, reinforcing wire, and plain rods necessary to complete the project, the quantity shown on the plans is increased or decreased by the theoretical computed weight of reinforcing steel added or subtracted by the change.

Spiral Column Reinforcing Steel or *Epoxy Coated Spiral Column Reinforcing Steel* will be measured and paid for as the number of pounds of spiral column reinforcing shown on the plans as being necessary to complete the work. Where the plans are revised, the quantity to be paid for is the quantity shown on the revised plans. Where directed to deviate from the plans in such a manner to change the quantities of steel bar reinforcement, reinforcing wire, and plain rods necessary to complete the project, the quantity shown on the plans is increased or decreased by the theoretical computed weight of spiral column reinforcing steel added or subtracted by the change.

The quantity of reinforcing steel or spiral column reinforcing steel shown on the plans is an estimate based on the theoretical computed weight of the steel necessary to complete the work, and will be used for pay purposes. No revision in this pay quantity nor any adjustment in the contract unit price for Reinforcing Steel or Spiral Column Reinforcing Steel will be made except where revisions in the plans affect the quantity of reinforcing steel or spiral column reinforcing steel necessary to complete the work or where an error has been found in the estimate of steel shown on the plans.

In the event that the elevation of the top of a footing is raised by a distance not exceeding 3 feet, and the reinforcing steel or spiral column reinforcing steel for the substructure unit

has been fabricated before the elevation was raised, no decrease in the quantity of steel to be paid for will be made from the theoretical weight of steel shown on the plans for the original substructure unit. Under the above circumstances the provisions of Article 109-6 will not apply as the steel not used in the work shall remain the property of the Contractor and payment for such steel will be made as provided above. No separate payment will be made for the cost of cutting off reinforcing steel or spiral column reinforcing steel as payment at the contract unit price per pound for the item of Reinforcing Steel or Spiral Column Reinforcing Steel will be full compensation for cutting the steel.

There will be no direct payment for reinforcing steel when the basis of payment or compensation clause applicable to a particular section of the Specifications states that payment at the contract unit or lump sum prices for the work covered by such section will be full compensation for furnishing and placing reinforcing steel.

No separate payment will be made for the work of furnishing and placing wire mesh reinforcement as payment at the contract unit price for the item or items covering the structure containing the mesh reinforcement will be full compensation for such work.

These prices and payments will be full compensation for all items required to fabricate and place reinforcement.

Payment will be made under:

Pay Item	Pay Unit
Reinforcing Steel	Pound
Epoxy Coated Reinforcing Steel	Pound
Spiral Column Reinforcing Steel	Pound
Epoxy Coated Spiral Column Reinforcing Steel	Pound

SECTION 430
ERECTING PRESTRESSED CONCRETE MEMBERS

430-1 DESCRIPTION

Furnish and erect precast-prestressed concrete bridge members other than piling. Furnish, galvanize, place, and paint, as applicable, bearing components, anchor bolts, diaphragm bars, washers, nuts, structural and reinforcing steel, miscellaneous hardware, paint, bearing assemblies, and all other materials; handle, transport, and store materials; furnish erection drawings; paint; set bearings and anchorage; grout, and erect and install the bridge members and all other items necessary to complete the erection in accordance with the requirements of the contract.

When used in this section, the term *prestressed concrete* refers to precast, pretensioned, prestressed concrete.

430-2 MATERIALS

Refer to Division 10:

Item	Section
Precast-Prestressed Members	1078
Plain Steel Bars, Threaded Ends	1074-3
Structural Steel	1072
Reinforcing Steel	1070
Organic Zinc Repair Paint	1080-9
Bearing Plate Assemblies	1072-5
Elastomeric Bearings	1079-2

430-3 HANDLING AND STORAGE

Take special care in handling, transporting, and storing prestressed members. Members damaged while handled or transported will be rejected unless repaired to the satisfaction of the Engineer.

Handle members at the bearings or at pick-up points designated on the plans unless using other methods approved in writing.

Transport prestressed concrete bridge girders in a horizontal upright position. Locate points of support and directions with respect to the girder approximately the same during transportation and storage as when the member is in the final position within the structure.

430-4 METHODS AND EQUIPMENT

Use methods and equipment to install prestressed members that result in satisfactory installation.

430-5 BEARINGS AND ANCHORAGES

Supply elastomeric bearings, when required by the plans, meeting the requirements of Section 1079.

Set steel sole plates level in exact position with full and even bearing on the bearing pad.

Accurately set anchor bolts in accordance with the requirements of Subarticle 420-12(A).

When welding the sole plate to the embedded plate in the girder, use temperature indicating wax pens, or other suitable means, to ensure that the temperature of the sole plate does not exceed 300°F. Temperatures above this may damage the elastomer.

Prior to welding, grind the galvanized surface of the portion of the embedded plate and sole plate that require welding. After welding, repair damaged galvanized surfaces in accordance with Article 1076-6.

430-6 ERECTION AND INSTALLATION

(A) General

Erect prestressed concrete members by methods that satisfy the handling requirements specified in Article 430-3.

Perform field welding in accordance with Article 1072-20 only when required on the plans.

When indicated on the plans, recess the ends of tie rods used in intermediate diaphragms of prestressed concrete girders. Fill these recesses with an approved non-metallic, non-shrink grout to match the neat lines of the girders.

When concrete is cast in contact with prestressed members, thoroughly clean and wet the surface of the member which contacts the fresh concrete for a minimum of 2 hours just prior to casting the fresh concrete.

After casting and finishing all concrete, thoroughly clean the prestressed members.

(B) Cored Slabs

When erecting prestressed cored slabs, place the 1/2" diameter transverse post tensioning strands and tension to 30,000 pounds in each span. Grease the transverse strands and place in a non-corrosive 1/2" diameter, 1/16" minimum wall thickness black polyethylene pipe meeting the requirements of ASTM D2239. Do not apply grease or extend the pipe in the area of the recesses at the ends of the tensioning strands where grout is applied. After tensioning the 1/2" diameter transverse strand in a span and before placing any equipment, material or barrier rail on the span, fill the shear key, dowel holes, and recesses at the ends of transverse strands with an approved non-metallic, non-shrink grout and cure for 3 days minimum, and until the grout reaches a compressive strength of 3000 psi.

After tensioning and curing, obtain approval prior to placing material and equipment on the cored slab spans. Support cranes or other equipment exceeding the legal load limit on mats. Submit for review a detailed drawing for the mats that are intended for use on the cored slabs. Provide a complete description of the equipment that is intended for placement on the mats. Supply and construct mats at no additional cost to the Department.

(C) Box Beams

The post tensioning system shall use 0.6" diameter strands. Strands shall be tensioned to 43,950 pounds. Strands shall be placed in a non-corrosive 0.6" diameter, 1/16" minimum wall thickness black polyethylene pipe meeting the requirements of ASTM D2239.

When erecting prestressed box beams, place the transverse post tensioning system in the diaphragms, place grout in the grout pockets located at the areas of the post tensioning strands, if provided, and tension to the required force. Grease the strands and place in the polyethylene pipe. Do not apply grease or extend the pipe in the area of the recesses at the ends of the tensioning strands where grout is applied. Tension the strands in the diaphragm nearest mid-span first. Proceed to tension strands in the adjacent diaphragms. Continue the tensioning operation in a symmetric manner along the length of the span. At each diaphragm location, maintain a symmetric tension force between each pair of strands in the diaphragm. After all tensioning in a span is completed and before placing any equipment, material or barrier rail on the

span, fill the shear key, dowel holes, and recesses at the ends of the diaphragm with an approved non-metallic, non-shrink grout. Cure for 3 days minimum and until the grout reaches a compressive strength of 3000 psi.

After tensioning and curing, obtain approval prior to placing material and equipment on the box beam spans. Support cranes or other equipment exceeding the legal load limit on mats. Submit for review a detailed drawing for the mats that are intended for use on the box beams. Provide a complete description of the equipment that is intended for placement on the mats. Supply and construct mats at no additional cost to the Department.

430-7 PAINTING

Clean, by hand or with power tools, and paint with 2 coats of organic zinc repair paint all ungalvanized steel surfaces, such as tie rod ends, not encased in concrete in accordance with Section 442. Provide a minimum dry thickness of each coat of paint of 1.5 mils.

430-8 MEASUREMENT AND PAYMENT

___" Prestressed Concrete Girders will be measured and paid for as the number of linear feet of prestressed concrete girders estimated on the plans as being necessary to complete the project.

3'-0" x 1'- __" Prestressed Concrete Cored Slabs will be measured and paid for as the number of linear feet of prestressed concrete cored slabs estimated on the plans as being necessary to complete the project.

3'-0" x _'-_" Prestressed Concrete Box Beams will be measured and paid for as the number of linear feet of prestressed concrete box beams estimated on the plans as being necessary to complete the project.

Concrete Box Beams will be measured and paid for as the number of linear feet of concrete box beams estimated on the plans as being necessary to complete the project.

Elastomeric Bearings will be paid at the contract lump sum price.

These prices and payments will be full compensation for all items required to erect prestressed concrete members, including but not limited to those items contained in Article 430-1.

Payment will be made under:

Pay Item	Pay Unit
__" Prestressed Concrete Girders	Linear Foot
3'-0" x 1'- __" Prestressed Concrete Cored Slabs	Linear Foot
3'-0" x __"-__" Prestressed Concrete Box Beams	Linear Foot
Concrete Box Beams	Linear Foot
Elastomeric Bearings	Lump Sum

SECTION 440
STEEL STRUCTURES

440-1 DESCRIPTION

Construct steel structures and steel structure portions of composite structures in conformity with the lines, grades, and dimensions shown on the plans and as specified in these Specifications.

Furnish, fabricate, galvanize, deliver, place, erect, clean, shop paint, and field paint structural metals and all other materials; furnish, erect, and remove falsework; set bearings and anchorage; weld; and furnish all materials for and assemble all structural joints. Structural metals include structural steels, metallic electrodes, steel forgings and castings, gray iron and malleable iron castings, drain pipes, and any incidental metal construction. Perform the above in conformity with the contract.

Before starting work, inform the Engineer as to the proposed method of erection.

440-2 MATERIALS AND FABRICATION

Refer to Division 10:

Item	Section
Structural Steel	1072
Steel Pipe	1074-6
Welded Stud Shear Connectors	1072-8
High Strength Bolts, Nuts, Washers, and Direct Tension Indicators	1072-7
Preformed Bearing Pads.	1079-1
Anchor Bolts	1072-6
Bearing Plate Assemblies	1072-5
Organic Zinc Repair Paint	1080-9
Elastomeric Bearings	1079-2

440-3 HANDLING AND STORING MATERIALS

Move, handle, and store all structural steel, in the shop, field and while being transported in accordance with Article 1072-11.

440-4 BEARINGS AND ANCHORAGES

Supply preformed bearing pads and elastomeric bearings, as required by the plans, meeting the requirements of Section 1079.

Set steel masonry plates level in exact position with full and even bearing on the preformed bearing pad.

Accurately set anchor bolts in accordance with the requirements of Subarticle 420-12(A).

Make sure that the location of anchors and setting of bearings take into account any variation from mean temperature at time of setting and anticipated lengthening of bottom flange due to dead load after setting, so that at mean temperature and under dead load the bearings are in a vertical position and anchor bolts at expansion bearings center in their

slots. Mean temperature is 60°F unless otherwise stipulated on the plans. Do not restrict full and free movement of the superstructure at the movable bearings by improperly setting or adjusting bearings or anchor bolts and nuts.

440-5 STRAIGHTENING BENT MATERIAL, HEAT CURVING AND HEAT CAMBERING

Straighten bent material, heat curve and heat camber as approved and in accordance with Article 1072-12.

440-6 FIELD ERECTION

Report immediately any error in the shop fabrication, or deformation resulting from handling and transporting, which prevents the proper assembling and fitting up of parts by more than the moderate use of drift pins or by more than a moderate amount of reaming, chipping, or cutting. Correct errors in the presence of the Engineer by approved methods.

Do not perform hammering which injures or distorts the members.

Limit the drifting during assembly to only that needed to bring the parts into position, and not sufficient to enlarge the holes or distort the metal. If any holes require enlarging to admit the bolts, ream or correct them by approved methods. Do not enlarge the holes more than 1/16" over the nominal size hole called for without written approval.

Before assembling the members, clean and dry to touch all bearing surfaces and permanently contacting surfaces.

For bolted splices and field connections, fill one half of the holes with bolts and cylindrical erection pins (half bolts and half pins) before placing permanent fasteners. For continuous units, pin and bolt all beam and girder splices and bring the splices to the correct elevations before permanently fastening. For bolted connections use fit-up bolts and optional shipping bolts with the same nominal diameter as the permanent fasteners, and use cylindrical erection pins which are 1/32" larger. Use permanent bolts as fit-up bolts if desired.

Use temporary bolts, including but not limited to shipping and fit-up bolts, supplied with square or hexagon heads and square or hexagon nuts. The use of hexagon head temporary bolts and nuts is allowed, but paint both the head and nut with a durable yellow paint prior to installation.

Do not reuse permanent bolts for final installation unless the nut is easily turned onto the bolt for the full threaded length by hand and without use of tools.

The use of erection bolts for field welded joints is allowed. Use erection bolts that are galvanized when the finish paint is applied in the structural steel fabrication shop and meet the requirements of AASHTO M164. Supplement these bolts with clamps as necessary to meet the AWS Specifications. Where unpainted AASHTO M270 Grade 50W structural steel is used, use erection bolts meeting the requirements of AASHTO M164 for Type 3 bolts.

After field welding the connection, leave the erection bolt in place with at least the minimum bolt tension shown in Table 440-1. Use holes that are 3/16" larger than the nominal erection bolt diameter.

440-7 FIELD WELDING

Perform field welding only when called for on the plans and in accordance with Article 1072-20.

Remove paint or galvanizing at the location of field welds by blast cleaning (SSPC SP-6 finish), or hand (SSPC SP-2 finish) or power tool cleaning (SSPC SP-3 finish) just prior to welding. Clean sufficiently to prevent contamination of the weld by the paint.

440-8 CONNECTIONS USING HIGH STRENGTH BOLTS

(A) General

This article covers the assembly of structural joints using plain or galvanized high strength carbon steel bolts with suitable nuts and washers tightened to a high tension. Use bolt holes that conform to the requirements of Article 1072-18.

Protect bolts, nuts, and washers from moisture during storage and so that they show no signs of rust at the time of installation.

Make sure that plain bolts, nuts, and washers have a thin coat of lubricant at the time of installation.

Apply beeswax, stick paraffin or other approved lubricant to the threads of galvanized bolts just prior to installing the bolts.

Use bolt, nut and washer (when required) combinations from the same rotational-capacity lot.

Perform the rotational capacity test described in Section 1072-7(D)(4) on each rotational-capacity lot prior to the start of bolt installation. Use hardened steel washers as required by the test.

(B) Bolted Parts

Make sure that the slope of surfaces of bolted parts in contact with the bolt head and nut does not exceed 1:20 with respect to a plane normal to the bolt axis. Make sure bolted parts fit solidly together when assembled and are not separated by gaskets or any other interposed compressible material. Provide contact surfaces, including those adjacent to the bolt heads, nuts, or washers, that are free of scale, dirt, burrs, oil, lacquer, loose rust, rust inhibitor, other foreign material, and other defects that prevent solid seating of the parts.

(C) Installation

(1) Bolt Tensions

Tighten each fastener to provide at least the minimum bolt tension shown in Table 440-1. Tighten fasteners by the turn-of-nut tightening method, with direct tension indicators in accordance with Subarticle 440-8(C)(6), or if permitted, by the use of load indicating bolts as provided in Subarticle 440-8(C)(4).

TABLE 440-1
REQUIRED BOLT TENSION

Bolt Size, Inches	Minimum Bolt Tension in Pounds
1/2	12,050
5/8	19,200
3/4	28,400
7/8	39,250
1	51,500
1 l/8	56,450
1 1/4	71,700
1 3/8	85,450
1 1/2	104,000

If necessary because of bolt entering and wrench operation clearances, tighten by turning the bolt while preventing the nut from rotating. Use impact wrenches, if necessary, with adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately 10 seconds.

(2) Washers

Make sure all fasteners have a hardened washer under the element (nut or bolt head) turned in tightening. Use galvanized washers when galvanized nuts and bolts are required. As an exception to the above, use special washers for oversize, short-slotted, and long-slotted holes in accordance with Subarticle 1072-18(H).

Where an outer face of the bolted parts has a slope of more than 1:20 with respect to a plane normal to the bolt axis, use a smooth beveled washer to compensate for the lack of parallelism.

(3) Turn-of-Nut Tightening

When using the turn-of-nut method to provide the required bolt tension, first provide enough bolts in a "snug tight" condition to bring the parts of the joint into full contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, place bolts in any remaining holes in the connection and bring to snug tightness. After bringing all bolts in a connection to snug tightness, match mark each nut, bolt shank, and the structural base metal wih a line of white ink or paint that is not water soluble. Additionally, mark the structural base metal to indicate the applicable amount of nut rotation specified in Table 440-2. Tighten all bolts in the joint additionally by the applicable amount of nut rotation specified in Table 440-2, progressing systematically from the most rigid part of the joint to its free edges. During this operation do not allow rotation of the part not turned by the wrench. To ensure compliance with this article, keep the match mark on the bolt shank and the initial mark on the structural base metal aligned.

Additionally, tighten to align the match mark on the nut and the mark representing the specified amount of nut rotation.

TABLE 440-2

NUT ROTATION [a] FROM SNUG TIGHT CONDITION

	Disposition of Outer Faces of Bolted Parts		
Bolt Length As measured from Underside of head to extreme end of point)	Both Faces Normal to Bolt Axis	One Face Normal to Bolt Axis and Other Face Sloped Not More Than 1:20 (bevel washer not used)	Both Faces Sloped Not More Than 1:20 From Normal to Bolt Axis (bevel washers not used)
Up to and Including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 Diameters but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 Diameters but not exceeding 12 diameters [b]	2/3 turn	5/6 turn	1 turn

[a] Applicable to coarse thread heavy hex structural bolts of all sizes and lengths up to 12 diameters, and heavy hex semi-finished nuts. Nut rotation is relative to the bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance should be plus or minus 30 degrees; for bolts installed by 2/3 turn and more, the tolerance should be plus or minus 45 degrees.

[b] When bolt lengths exceed 12 diameters, the required rotation shall be determined by actual tests in a suitable tension device simulating the actual conditions.

(4) Load Indicating Bolts

Tightening by use of a load indicating bolt system is permitted provided it can be demonstrated by an accurate direct measurement procedure that the bolt is tightened in accordance with Table 440-1. Tighten by approved methods and procedures.

(5) Galvanized High Strength Bolts

Use mechanically galvanized high strength bolts in all bolted connections for painted structural steel.

Install galvanized high strength bolts carefully so that shop painted surfaces are not scarred or otherwise damaged.

Repair galvanized surfaces that are abraded or damaged by thoroughly wire brushing the damaged area and removing all loose and cracked coating, after which give the cleaned area 2 coats of organic zinc repair paint.

(6) Direct Tension Indicators

Supply direct tension indicators in accordance with the requirements of ASTM F959, Article 1072-7, and the manufacturer's recommendations.

Install the direct tension indicators in strict compliance with the manufacturer's written instructions.

Furnish to the Engineer a copy of the manufacturer's instructions for installing the direct tension indicators along with at least one metal feeler gage for each container of direct tension indicators shipped before beginning installation.

Make sure that the lot number on the containers of direct tension indicators is for the same lot number tested as indicated on the test documents.

Furnish to the Engineer three samples of load indicating washers from each lot number, each size and type for tests and two each of the metal feeler gages required for performing the tests.

Install the direct tension indicator under the bolt head. If it is necessary to install the direct tension indicator under the nut, or if the bolt head shall be turned, install additional hardened washers in accordance with the manufacturer's instructions.

Provide a tension indicating device on the project for determining the tension imposed on a fastener when the protrusions on direct tension indicator are properly compressed.

Test 3 samples from each lot of direct tension indicators in the presence of the Engineer. Achieve a minimum bolt tension of 5% greater than that required by Table 440-1 of Article 440-8.

Do not substitute direct tension indicators for hardened steel washers required with short slotted or oversized holes. If desired, use direct tension indicators in conjunction with hardened steel washers.

Install direct tension indicators initially to a snug tight condition as specified in Subarticle 440-8(C)(3). After initial tightening, fully tighten as recommended by the manufacturer, beginning at the most rigid part of the joint and continuing toward its free edges.

For tightening fasteners containing direct tension indicators, use a clean and lubricated wrench of type and capacity recommended by the manufacturer. Maintain air supply and hoses in good condition and provide air pressure of at least 100 psi at the wrench.

When tightening the fasteners, ensure that the part of the fastener being restrained from turning does not rotate during the tightening process. Ensure that no portion of the direct tension indicator protrusions is accidentally partially flattened before installing in the structural steel joints.

Do not reuse direct tension indicators. If it is necessary to loosen a bolt previously tensioned, discard and replace the direct tension indicator.

(D) Inspection

Allow the Engineer the opportunity to observe installation of bolts to determine that the selected tightening procedure is properly used. The Engineer determines when bolts are properly tightened and in the case of direct tension indicator bolts that the correct indication of tension is achieved. Where the turn-of-nut method is used, each bolt is inspected visually for the correct relationship between the match marks on the nut and the bolt shank. Bolts installed by the turn-of-nut method may reach tensions above the value given in Table 440-1 but this is not a cause for rejection. After properly tightening bolts, make sure that the end of the bolt is flush with or extended beyond the outer face of the nut.

Do not begin painting in the area of tightened bolts until after bolt inspection is complete.

In addition to inspecting the match mark relationship with the turn-of-nut method, use the following inspection procedure unless the contract requires a more extensive or different inspection procedure.

As directed, furnish and use, in the presence of the Engineer, or allow the Engineer to use an inspection torque wrench, calibrated as follows:

At least once each working day, place 3 calibration sample bolts of the same grade, size, representative length, and conditions as those under inspection in a tension indicating calibration device. Furnish a tension indicating calibration device certified by an approved independent testing lab within 6 calendar months prior to testing the bolts under inspection, to be in good working order and to provide accuracy within plus or minus 10 percent for the range of loads between 25,000 and 40,000 pounds. Place a washer under the part turned in tightening for each bolt if washers are so used in the structure. If no washer is used make sure that the material abutting the part turned is the same as that used in the structure.

Tighten each calibration sample bolt in the calibration device by any convenient means to an initial condition equal to 15 percent of the required tension and then to the minimum tension specified in Table 440-1. Then apply the inspecting wrench to the tightened bolt and determine the torque necessary to turn the nut or head 5 degrees (approximately 1" at 12" radius) in the tightening direction. Use the average torque measured in the tests of 3 bolts as the job inspecting torque.

Use the inspection wrench to inspect bolts, represented by the calibration sample bolts, which are tightened in the structure by applying in the tightening direction the job inspecting torque to 10 percent of the bolts, but not less than 2 bolts, selected at random in each connection. If no nut or bolt head turns by this application of the job inspecting torque, the connection is acceptable as properly tightened. If any nut or bolt head turns by the application of the job inspecting torque, apply this torque to all bolts in the connection. Tighten and reinspect all bolts whose nut or head turns by the job inspecting torque. Alternatively, retighten all the bolts in the connection and resubmit the connection for the specified inspection.

When using direct tension indicators, proper tension of bolts is inspected by the Engineer by inserting a 0.005-inch thickness feeler gage into the openings between adjacent flattened protrusions of the direct tension indicator. Proper tension is obtained when the number of spaces for which the gage is refused is equal to or greater than the value shown in Table 440-3.

TABLE 440-3
Direct Tension Indicator Gap Refusal

Number of Spaces in Washer	Number of Spaces Gage is Refused*
4	2
5	3
6	3
7	4

* The gage shall be refused in all spaces when the direct tension indicator is used under the turned element.

When using direct tension indicators, do not tighten bolts to a no visible gap condition.

Inspections of direct tension indicator installations are made by the Engineer by the use of the metal feeler gauges provided by the Contractor. At least 10%, but no less than two of the bolts in each connection are inspected with feeler gauges. Additionally, all remaining bolts in each connection are visually inspected for proper tightening.

440-9 SURFACE PREPARATION AND PROTECTION OF WEATHERING STEEL

After fabrication, shop clean all weathering steel remaining in the unpainted condition in the completed structure to a SSPC SP-6 finish. Provide a contact surface condition in accordance with Subarticle 442-8(B) at the time of bolt installation.

Protect the structural steel during concreting and any other operations that are particularly hazardous with respect to soiling the steel. Remove any foreign matter which gets on the steel as soon as possible by either solvent cleaning, hand tool cleaning, power tool cleaning, blast cleaning, or a combination thereof, as necessary to restore the surfaces to the specified condition.

440-10 MEASUREMENT AND PAYMENT

Approximately _____ Pounds Structural Steel will be measured and paid for at the contract lump sum price. The approximate quantity shown in the contract pay item is an estimate based on the computed weight of the structural steel necessary to complete the work. No measurement for payment will be made for this pay item, and no adjustment in the contract lump sum price will be made for any variation from the approximate quantity shown except for revisions in the plans which affect the quantity of structural steel necessary to complete the work.

When revisions in the plans have been made which affect the quantities of structural steel, adjustments in compensation will be made by supplemental agreement.

When the contract includes the item of Painting of Structural Steel, all work of painting except for shop painting will be paid for as provided in Article 442-14 and payment for shop painting will be included in the contract lump sum price for "Approximately _____Pounds Structural Steel". When the contract does not include the item of Painting of Structural Steel, payment at the contract lump sum price for Approximately _____Pounds Structural Steel will be full compensation for both shop and field painting.

Elastomeric bearings will be paid for as provided in Article 430-8.

The price and payment will be full compensation for all items required to construct steel structures including but not limited to those items contained in Article 440-1.

Payment will be made under:

Pay Item	**Pay Unit**
Approximately _____Pounds Structural Steel	Lump Sum

SECTION 442
PAINTING STEEL STRUCTURES

442-1 DESCRIPTION

Paint steel structures and properly prepare metal surfaces; apply, protect, and dry paint coatings; protect pedestrian, vehicular, water, or other traffic upon or underneath the structure; protect all portions of the structure and adjacent work against disfigurement by splatters, splashes, overspray, and smirches of paint or of paint materials; apply paint in the shop and field; and furnish blast cleaning equipment, paint spraying equipment, brushes, rollers, paint cleaning abrasives, cleaning solvents, tools, tackle, scaffolding, labor, and any other materials, hand or power tools, inspection equipment, and personal protective and safety equipment necessary for the entire work.

442-2 MATERIALS

Refer to Division 10:

Item	Section
Paint and Paint Materials	1080

442-3 PROTECTION OF WORK

Protect all parts of the structure against disfigurement by splatters, splashes, overspray, and smirches of paint or of paint materials. Assume responsibility for any damage or disfigurement caused by operations to vehicles, persons, or property, including plants and animals; and provide protective measures to prevent such damage.

Thoroughly clean and restore any surface or surfaces disfigured by splatter, overspray, splashes, smirches, etc., to its original condition.

Restore any damaged structure or surface to its original condition.

If traffic causes dust considered by the Engineer to be detrimental to the work, sprinkle dust producing areas with water or dust palliative and take any other necessary precautions to prevent the accumulation of dust and dirt on freshly painted surfaces.

442-4 ACCESS TO THE WORK

Provide safe and convenient access to all parts of the work in accordance with Section 105-11.

442-5 APPLICATION CONDITIONS

Unless the paint manufacturer's application instructions are more restrictive, obtain written permission to apply paint when the temperature of the air or metal is below 50°F, when freezing weather is forecast during the drying period, or when the metal is hot enough to cause the paint to blister or produce a porous paint film. Also, do not apply paint or perform any surface preparation when the air is misty; in the rain, snow, or fog, or when the steel surface temperature is less than 5°F above the dew point, or as directed.

Provide adequate and safe storage for all paint and equipment. Do not expose paint materials to rain, excessive condensation, long periods of direct sunlight, or temperatures above 110°F or below 40°F. Follow the manufacturer's storage requirements if more restrictive than the above requirements.

Replace paint damaged by any cause at no cost to the Department.

442-6 MIXING PAINT

Mix paint in accordance with the manufacturer's instructions and Article 1080-1.

442-7 PAINT SYSTEMS

Include in the system surface preparation, shop painting, and/or field painting. Use all paints and solvents for shop and field application that are produced by the same manufacturer.

Use approved/qualified paint products found in Section 1080. Apply the paint system required by the plans and at the film thickness indicated below. Coating thickness in excess of the maximum dry film thickness is acceptable as long as the coating is free of visible defects (runs, sags, cracking, lifting).

SYSTEM 1 INORGANIC ZINC (IOZ) PRIMER AND ACRYLIC TOP COATS

Coat	Material	Mils Dry/Wet Film Thickness	
		Min	Max
Primer	1080-7 IOZ	3.0 DFT	5.0 DFT
Intermediate	1080-12 Brown	2.0 DFT	4.0 DFT
Stripe	1080-12 White	4.0 WFT	7.0 WFT
Topcoat	1080-12 Gray	3.0 DFT	5.0 DFT
Total		8.0 DFT	14.0 DFT

Apply System 1 to non-weathering steel surfaces cleaned to an SSPC SP-10 finish. Shop apply the IOZ primer, two coats of acrylic paint, and one strip coat of acrylic paint over all structural steel surfaces except as otherwise specified. As an option, acrylic paint may be applied in the field. Apply the primer to the shear connectors and all surfaces of the top flange. Completely cure the inorganic zinc primer to meet the requirements of ASTM D4752 before top coating. Ensure that the Elcometer Adhesion of the zinc primer is no less than 400 psi when tested in accordance with ASTM D4541. If bubbling occurs during the application of the first field coat, apply a mist coat of brown paint to prevent further bubbling. Ensure that the Tape Adhesion of the cured system is no less than 3A when tested in accordance with ASTM D3359.

SYSTEM 2 INORGANIC ZINC (IOZ) PRIMER AND COAL TAR EPOXY TOP COATS

Coat	Material	Mils Dry/Wet Film Thickness	
		Min	Max
Primer	1080-7 IOZ	3.0 DFT	5.0 DFT
Intermediate	1080-8 Red	8.0 DFT	12.0 DFT
Topcoat	1080-8 Black	8.0 DFT	12.0 DFT
Total		19.0 DFT	NA

Apply System 2 on non-weathering steel surfaces cleaned to an SSPC SP-10 finish. Shop painting consists of painting with a primer, and two coats of coal tar epoxy paint over all structural steel surfaces except as otherwise specified. Completely cure the inorganic zinc primer to meet the requirements of the ASTM D4752 solvent rub test before top coating. Ensure that the Elcometer Adhesion of the zinc primer is no less than 400 psi before top coating when tested in accordance with ASTM D4541. Apply the finish coat when the first coat of coal tar epoxy is still tacky. Ensure that the Elcometer Adhesion of the cured system is no less than 400 psi when tested in accordance with ASTM D4541.

SYSTEM 3 ACRYLIC PRIMER AND TOP COATS

Coat	Material	Mils Dry/Wet Film Thickness	
		Min	Max
Primer	1080-12 Brown	2.0 DFT	4.0 DFT
Intermediate	1080-12 White	2.0 DFT	4.0 DFT
Stripe	1080-12 Brown	4.0 WFT	7.0 WFT
Topcoat	1080-12 Green	2.0 DFT	4.0 DFT
Topcoat	1080-12 Gray	2.0 DFT	4.0 DFT
Total		8.0 DFT	16.0 DFT

Apply System 3 in the field or shop to non-weathering steel surfaces cleaned to an SSPC SP-6 finish. Painting consists of painting with two primer coats, a stripe coat and two finish coats over all structural steel surfaces except as otherwise specified. Provide a curing period for the first primer coat of paint of at least 24 hours. Ensure that the Tape Adhesion of the cured system is no less than 3A when tested in accordance with ASTM D3359.

SYSTEM 4 ACRYLIC PRIMER AND TOP COATS FOR WEATHERING STEEL

Coat	Material	Mils Dry/Wet Film Thickness	
		Min	Max
Primer	1080-12 Brown	2.0 DFT	4.0 DFT
Intermediate	1080-12 White	3.0 DFT	5.0 DFT
Stripe	1080-12 Brown	4.0 WFT	7.0 WFT
Topcoat	1080-12 Brown	2.0 DFT	4.0 DFT
Total		7.0 DFT	13.0 DFT

Apply System 4 to weathering steel surfaces cleaned to an SSPC SP-6 finish. Shop painting consists of applying all primer and finish paints at the ends of beams or girders within a distance of 1 1/2 times the depth of the beam or girder at the bearing except as otherwise specified. Provide a curing period for the first primer coat of paint of at least 24 hours. Ensure that the Tape Adhesion of the cured system is no less than 3A when tested in accordance with ASTM D3359.

SYSTEM 5 OIL/ALKYD PRIMER AND ALKYD TOP COATS

Coat	Material	Mils Dry/Wet Film Thickness	
		Min	Max
Spot Primer	1080-5 Red +	1.5 DFT	3.0 DFT
Primer	1080-5 Red	1.5 DFT	3.0 DFT
Stripe	1080-5 Red +	3.0 WFT	5.0 WFT
Topcoat	1080-6 Gray +	2.0 DFT	4.0 DFT
Topcoat	1080-6 Gray	2.0 DFT	4.0 DFT
Total		7.0 DFT	14.0 DFT

Apply System 5 in the field overcoating old oil/alkyd paint systems. Painting consists of two primer coats (one on spots which have been cleaned to an SSPC SP-3 finish) and the other over the repairs and the old paint. If applying System 5 to new structural steel, apply

the first prime coat in the shop and apply the remaining coats after erecting the steel and placing all concrete. Apply a stripe coat of primer and two finish coats over all structural steel surfaces except as otherwise specified. Provide a curing period for the first primer coat of at least 24 hours. The "+" indicates the addition of an approved tinting pigment to achieve a color difference. Ensure that the Tape Adhesion of the cured system in the areas of spot repairs, is no less than 3A when tested in accordance with ASTM D3359.

442-8 SURFACE PREPARATION

(A) Blast Cleaning

Use a blast profile which is 1.0 to 3.0 mils and angular. The degree of cleaning required is indicated under the specified paint system. Unless otherwise specified, clean all other steel surfaces to be coated or metallized to meet SSPC SP-10. Clean weathering steel surfaces to be painted to achieve a SSPC SP-6 finish.

Blast clean by centrifugal or forced air blasters. When using forced air blasters, use blast nozzles with a minimum 5/16" orifice and operate at no less than 100 psi when measured with a needle gage at the nozzle. Use dry blasting for all blast cleaning. Select a size or grade of abrasive that provides the specified finish and profile meeting the requirements of Article1080-15.

Perform blast cleaning operations in such a manner that no damage is done to partially or entirely completed portions of the work

After blasting, brush the surface with clean brushes made of hair, bristle, or fiber; blow off with compressed air, or clean by vacuum so that any traces of blast products from the surface and any abrasive from pockets and corners are removed.

Use compressed air for nozzle blasting that is free of detrimental amounts of water or oil. Provide adequate separators and traps.

Examine the blast cleaned surface for any traces of oil, grease, or smudges deposited in the cleaning operations. If present, remove them by an approved method. Have the degree of cleanliness and profile approved prior to painting.

When blast cleaning structures open to traffic, provide suitable protective enclosures to prevent damage to public and private property. Do not blast directly over traffic without prior approval of the Engineer.

When blast cleaning near bridge machinery, seal all journals, bearings, motors, and moving parts against entry of abrasive dust before blast cleaning.

Unless otherwise authorized, prime or treat blast cleaned surfaces to be painted no later than 8 hours after blast cleaning is complete. Reclean the cleaned surfaces that contain rust or are contaminated with foreign material before painting or bolting.

(B) Hand or Power Tool Cleaning

Thoroughly remove loose paint, rust, scale, dirt, oil, grease, and other detrimental substances by hand cleaning (SSPC-SP2), power tool cleaning (SSPC-SP3), or any combination of these methods. Hand cleaning includes the use of metal brushes,

grinders, sanders, or any approved combination of these tools. Use bristle or wood fiber brushes to remove loose dust.

442-9 APPLICATION OF PAINT

(A) General

Unless otherwise permitted, apply all paint by spraying, except apply the stripe coat by brush or roller. The use of a brush or roller is permitted to make minor repairs to the primer.

Make sure that the applicator has a current copy of the paint manufacturer's application instructions, along with Material Safety Data Sheets for each paint; and furnish 2 copies to the Engineer. Unless otherwise required herein, apply in accordance with the manufacturer's instructions.

Do not start applying paint until the paint materials are approved.

Both Shop and Field applicators are required to conduct and document quality control inspection of the painting, including measurements of temperature, dew point, surface profile, and paint thickness. Make sure that the paint applicator has the Engineer’s pre-approved procedure for repair of all damage and defects.

The Engineer approves all paint thinning activities. The paint products specified in Section 1080 do not require thinning when applied under normal conditions. Obtain written approval for any thinning necessitated by weather conditions or other causes. Only those thinners approved by the paint manufacturer as described in the application instructions are permitted.

Paint in a neat and workmanlike manner. Apply the paint so as to provide a tight film of the specified thickness, well bonded to the metal or previously applied paint, and free of laps, streaks, sags, or other defects.

Make sure each coat of paint is in a proper state of cure or dryness before applying the succeeding coat. Where necessary, clean each coat of paint in accordance with Subarticle 442-8(B).

When a stripe coat is required, apply a 2" stripe by brush or roller to all exposed edges of steel before applying the finish coat. Locate the edge or corner in the approximate center of the paint stripe.

(B) Spray Application

Use equipment for spray application of paint that is suitable for the intended purpose, capable of properly atomizing the paint, and equipped with suitable pressure regulators and gages. Use air caps, nozzles, and needles recommended by the manufacturer of the equipment for the material being sprayed. Keep the equipment in satisfactory condition to permit proper paint application. In closed or recirculating paint spray systems where gas under pressure is used over the liquid, use an inert gas, such as nitrogen.

Provide and drain periodically during operations, adequately sized traps or separators to remove oil and water from the compressed air. Make sure that the air from the spray gun impinging against the surface shows no water or oil.

Use an agitated spray pot. Adjust the agitator or stirring rod to reach within 2" of the bottom of the spray pot and be in motion at all times during paint application. Provide sufficient motion to keep the paint well mixed.

Apply paint in a uniform layer, with overlapping at the edge of the spray pattern. Adjust the spray pattern so that the paint is deposited uniformly.

442-10 SHOP PAINTING

(A) General

Shop painting is the painting of structural steel in an enclosed shop or plant before shipment to the site of erection. The work in this section applies to previously uncoated steel and includes the proper preparation of the metal surfaces and the application, protection, and cure/drying of coatings. Complete all shop fabrication, including welding and attachment of shear connectors, before painting is started.

(B) Painted Areas

(1) Do not paint the following surfaces:

Bearing assemblies, plates, etc. called for as galvanized or metallized.

Areas where field welding is to be performed.

Outside surfaces of splice plates (Systems 3 and 5 only).

Plate surfaces contacting elastomeric bearing pads

Contact surfaces with blockouts for bolted connections on curved girder bridges and beam and girder splices (Systems 3 and 5 only). In the areas of these blockouts, extend the finish paint no closer than 2" nor more than 3" from the edges of contact surfaces in bolted connections. Ensure that the primer paint is clearly visible around these areas when the structural steel is assembled. The same offset dimensions are required for finish paint at field welds, measured from the proposed location of the field weld.

(2) Areas where paint is not required and overspray is permitted include:

Bolt holes.

Shear connectors and top surface of top flange.

(3) Clean and paint stiffener clips and other inaccessible areas on a best effort basis. Such areas are those that contain enclosed surfaces, the majority of which are not visible.

(4) Apply a stripe coat on all corners and raised welds.

(5) Provide a shop certification by American Institute Steel Construction (AISC) Sophisticated Paint Endorsement (SPE) or Society of Protective Coatings

(SSPC) Qualification Procedure Three (QP3) when the quantity is greater than 1500 square feet of painted steel.

(6) Provide a repair procedure for all damage and defects for approval before painting.

(7) Paint erection marks for the field identification of members and weight marks upon surface areas previously painted with a shop coat. Do not load material for shipment until the paint is thoroughly dry, and in any case not less than 24 hours after applying the paint.

(C) Definitions

A **Corner** is defined as the intersection of two surfaces that are not in the same plane.

Inaccessible areas are partially or completely enclosed surfaces, the majority of which are not visible without the use of special devices such as mirrors.

A **Sharp Edge** is a corner on a steel section that terminates in a point or edge and appears able to cut human flesh.

A **Stripe Coat** is an additional coat of paint applied to the edges, outside corners, and areas difficult to coat by spray before or after a full coat is applied to the surface. The stripe coat is intended to give those areas sufficient film build and coverage to resist corrosion.

(D) Surface Preparation

The requirements of Article 442-8 apply to surface preparation of steel surfaces in the shop. Abrasive Cleanliness: Check abrasives daily for contaminants or as otherwise directed by the Engineer. Verify that abrasive material meets the cleanliness requirements of SSPC AB1 or SSPC AB2 depending on the abrasive material used.

The following items are required as a part of preparation and cleaning:

(1) Corner Condition: Bevel corners to an approximate 1/16” chamfer if the included angle is less than 90 degrees.

(2) Surface Irregularities: Remove slivers, hackles, tears and projection of blast cleaned steel. Restore the profile in areas larger than one square foot.

(3) Weld Spatter: Remove excessive weld spatter and all loose weld spatter. Tightly adherent weld spatter is allowed unless it is sharp. Flatten sharp weld spatter.

(4) Bolts: Shop installed galvanized bolts on which the coating is disturbed or distressed during shop cleaning is of no concern as long as the coating system is applied over them. If necessary, after installation, clean shop installed black bolts in accordance with SSPC Surface Preparation 1 Solvent Cleaning. Blast clean or otherwise clean by an approved alternative method the bolts before shop priming.

442-11 FIELD PAINTING

Field painting is conducted after erection, or when damage to a shop applied coating system is repaired, or when steel is otherwise painted outside an enclosed shop environment. A SSPC QP1 certified contractor shall perform work.

Obtain written permission from the Engineer to apply field coats of paint between December 1 of one year and May 1 of the following year inclusive. Do not apply any coating below 32°F or when a temperature of 32°F or below is predicted during the drying and curing period of the paint. Do not apply any coating above or below the manufacturers recommended application temperatures or during a period when an ambient temperature outside the recommended range is predicted during the drying and curing period of the paint. Obtain written approval for suitable enclosures if wishing to use such enclosures during adverse weather conditions. Use enclosures that control atmospheric conditions artificially inside within limits suitable for painting during the painting operation and until the paint is dry/cured or until weather conditions permit its exposure in the open.

Do not apply paint in rain, fog or when wind velocity is continuously greater than 10 miles per hour. Harsh environments may necessitate re-cleaning during or between paint applications.

Do not apply paint over traffic without prior written approval from the Engineer.

Touch-up of shop painted non-weathering steel consists of painting with primer and finish paint over all the previously uncoated exposed metal surfaces. When the repair area exceeds one square foot, clean, prime, and topcoat damaged areas in accordance with Subarticle 442-8(A). Otherwise clean, prime, and topcoat damaged areas in accordance with Subarticle 442-8(B). For systems with shop applied topcoats, apply an additional field appearance coat of finish paint to the outside surface of all exterior beams on non-weathering steel bridges over highways and navigable waterways.

When an appearance coat of finish paint is required, paint the portion of galvanized high strength bolts on the outside face of exterior beams or girders with primer and appearance coat of the finish paint. Apply the primer to the galvanized high strength bolts by brush so that the primer is not applied to the adjacent finish paint.

At the location of field welds, satisfactorily remove all paint or galvanizing by blast cleaning, or hand or power tool cleaning just prior to welding. Clean sufficiently to prevent contamination of the weld by the paint.

Final acceptance by the engineer will be after erection of the structure, when the final coat has been applied, and all repairs effected.

Clean all contaminants such as soil, concrete, weld splatter, grease, or any other deleterious material from the steel or shop coated surfaces before any painting operations begin. Harsh environments may necessitate re-cleaning during or between paint applications.

442-12 INSPECTION

Only NCDOT Certified Coating Level 1 inspectors shall inspect the field-coating application.

Ensure that the coating applicator maintains a daily quality control record. The information required in the record is listed on Materials and Tests Form M&T-610. Maintain quality control data in a log and format approved by the Engineer. Enter data on a daily or immediate basis as coating activities are conducted. Ensure that the applicator's quality control representative signs and dates each entry.

Apply all coatings in accordance with SSPC PA1. Repair all coating defects or nonconformities in accordance with SSPC PA1. Make repairs to the topcoat with a uniform gloss and color on visible surfaces. The engineer makes the final decision concerning uniformity and appearance.

442-13 REPAINTING OF EXISTING STEEL STRUCTURES

Repaint existing steel structures in accordance with Article 442-1 through 442-12 and the requirements of this section.

(A) Pollution Control

During field painting operations, utilize all necessary precautions to prevent dispersion of surface preparation debris, paint, or any other material outside the work area due to wind or any other reason.

(B) Hazardous Paint Removal

Should the existing paint system include toxic substances such as red lead oxide which is considered hazardous if improperly removed, furnish a containment and spill control plan for surface preparation and painting operations and await review and approval of said plan before beginning work. This plan shall meet or exceed the requirements of Class 2A in accordance with SSPC Guide 6I. This work shall be performed by a SSPC QP2 certified contractor.

Monitor air quality. Any visible emissions outside the containment structure or air quality monitoring results exceeding the permissible OSHA action level is justification for suspension of the work. Monitor air quality at random locations within 1 to 5 feet from the enclosure in accordance with NIOSH Method 7082.

Immediately collect and retain any spilled dust or paint debris in approved containers. Should a spill result in soil or water contamination, take all necessary actions to remediate the site to its original state.

Waste Handling

Treat and consider all paint debris generated during the work as hazardous waste.

Collect debris from surface preparation operations in bulk dumpsters or other suitable metal containers approved by the Waste Disposer and Engineer.

Permanently identify each container with a date and identification number. At the end of the work shift, collect all debris generated for that day in the container. No

subsequent work is permitted until all debris is properly collected and stored. Store the containers in a fenced or otherwise secured area in an approved location to prevent damage or vandalism.

Clean and dispose of any incidental materials or equipment that are contaminated as the result of work activities on the project.

Waste Disposal: Dispose of waste in accordance with North Carolina's Hazardous Waste Rules 15A NCAC 13A.

(C) Health and Safety Responsibility

In addition to the requirements of Article 105-11 Inspection of Work, Section 106 Control of Material, and Section 107 Legal Relations and Responsibility to Public, provide effective engineering and work practice controls to insure adequate protection.

Prior to beginning work, certify to the Engineer that all personnel involved with lead paint removal operations (including rigging and material handling personnel) are properly trained and understand the applicable parts of EPA 40 CFR Part 745 and OSHA Standards 29 CFR 1910 and 29 CFR 1926 including any amendments in force at the time of this contract.

442-14 MEASUREMENT AND PAYMENT

When the contract does not include the item of Painting of Structural Steel, there will be no direct payment for the work covered by this section.

When the contract includes the item of *Painting of Structural Steel*, all work covered by this section except for shop painting will be paid for at the contract lump sum price for this item. Payment at the contract lump sum price for Approximately _____ Pounds Structural Steel will be full compensation for the work of shop painting.

These prices and payments will be full compensation for all items required to paint steel structures including but not limited to those items contained in Article 442-1.

Pollution Control will be paid for as the contract lump sum price.

When provided for in the contract, payment will be made under:

Pay Item	Pay Unit
Painting of Structural Steel	Lump Sum
Pollution Control	Lump Sum

SECTION 450
BEARING PILES

450-1 DESCRIPTION

Furnish and drive bearing piles as shown on the plans and as directed by the Engineer to the required bearing and penetration. Furnish, weld, and attach steel pile points, pipe pile plates, pile tips and splicers; provide collars, hardware, concrete, reinforcing steel, and all other materials; furnish all equipment, preauger through embankments, install piles

vertically or on a batter; galvanize, cut off, splice, and build up piles; place concrete and reinforcing steel; construct pile trestles; furnish and place temporary bracing; remove any obstructions; wrap, bolt, or fasten timber fender piles; and abandon, remove, replace, and restrike or redrive piles as necessary.

450-2 MATERIALS

Refer to Division 10:

Item	Section
Timber Piles, Prestressed Concrete Piles, Steel Pipe and H Piles	1084
Portland Cement Concrete	1000

450-3 PREPARATION FOR DRIVING

If applicable, completely excavate for the cap and/or footing before installing piles. If applicable and unless noted otherwise on the plans, construct the embankment to the bottom of cap or footing elevation for a horizontal distance of 50 feet from any pile except where fill slopes are within 50 feet of a pile. If preaugering through an embankment is necessary before driving prestressed concrete piles, submit the preaugering and pile installation methods with the proposed pile driving methods and equipment for approval.

450-4 DETERMINATION OF PILE LENGTH

The estimated total pile lengths per structure shown on the plans are for bid purposes only. Determine pile lengths and furnish piling of sufficient length to obtain the required bearing and penetration and the required embedment into the cap or footing as shown on the plans. As an option and at no cost to the Department, make investigations as necessary to determine the required pile lengths.

450-5 DRIVING EQUIPMENT

Submit the proposed pile driving methods and equipment including the pile driving hammer, hammer cushion, pile helmet and cushion, if any. Do not submit more than two pile driving hammers per pile type per submittal. Submit this information for approval at least 20 working days before driving piles. All equipment is subject to satisfactory field performance.

Drive bearing piles with approved driving equipment using steam, air, or diesel hammers. Use pile driving hammers with an energy that will not overstress the piles during driving and provide the required driving resistance at blows per foot ranging from 36 to 96, unless approved otherwise by the Engineer. Use a variable energy hammer to drive prestressed concrete piles.

Operate steam, air, or diesel hammers at the length of stroke and number of blows per minute required by the Engineer. Operate air and steam hammers within 10% of the manufacturer's rated speed in blows per minute or the rate approved by the Engineer.

Provide plant and equipment for air or steam hammers with sufficient capacity to maintain, under working conditions, the volume and pressure specified by the manufacturer. Equip the plant and equipment with accurate pressure gauges that are easily accessible. Use

striking parts of air and steam hammers that weigh at least 1/3 the weight of the pile helmet and pile, with a minimum weight of 2,750 pounds.

Equip open-end (single acting) diesel hammers with a graduated scale (jump stick) extending above the ram cylinder, graduated rings or grooves on the ram, or an electric sound activated remote measuring instrument to allow the Engineer to visually determine hammer stroke at all times during pile driving operations.

Equip closed-end (double acting) diesel hammers with a calibrated bounce chamber pressure gauge, in good working order, mounted near ground level and easily read by the Engineer. Also, provide a current calibrated chart or graph equating bounce chamber pressure and gauge hose length to equivalent energy for the closed-end diesel hammer used. Submit this chart or graph with the proposed pile driving methods and equipment required above.

Protect and hold pile heads in position with an approved pile helmet. Make sure that the pile helmet closely fits the top of the pile and extends down the sides of the pile a sufficient distance to hold the pile in position. Protect the heads of concrete and timber piles from direct impact with an approved pile cushion. Provide collars or bands to protect timber piles against splitting or brooming where required.

450-6 ACCURACY OF DRIVING

Drive piles so that the axial alignment is within 1/4" per foot from the vertical or batter shown on the plans. Horizontally, keep the pile within 3" of the plan location longitudinally and transversely. Maintain pile embedment in the cap or footing to within 3" more or 2" less than that shown on the plans. No additional payment is made for increased cap or footing dimensions necessary due to piles driven out of position.

450-7 CONSTRUCTION REQUIREMENTS

(A) General

Unless otherwise approved or directed by the Engineer, do not drive piles within 50 feet of cast-in-place concrete until the concrete attains an age of at least 3 curing days. When approved by the Engineer, the Contractor may use vibratory hammers to install the initial portions of steel piles. The Engineer will approve the depth of pile installation with the vibratory hammer. Do not use vibratory hammers to install prestressed concrete piles.

The Engineer will inspect the capblock before beginning each pile driving project and periodically throughout the duration of the project, depending on driving conditions as determined by the Engineer. Expose the hammer cushion for inspection as directed by the Engineer. Replace or repair any hammer cushion that is less than 25% of the original thickness.

Do not exceed the allowable pile driving stresses during the entire driving time. Allowable pile driving stresses are defined in the *AASHTO Standard Specifications for Highway Bridges*. Drive piles to the required tip elevation or penetration into natural ground, whichever is lower, in a continuous operation unless stopped due to exceeding the maximum blow count or the allowable pile driving stresses,

insufficient pile length, or other reasons approved by the Engineer. Once the required embedment is achieved, the Engineer may require the Contractor to stop driving and wait before restriking to allow for soil setup.

Use a pile cushion made of pine plywood with a 4" minimum thickness for driving prestressed concrete piles. When using a pile cushion, provide a new cushion for each pile unless approved otherwise by the Engineer. Replace the pile cushion if, during the driving of any pile, the cushion is either compressed more than one-half the original thickness or begins to burn.

Redrive any pile raised or moved laterally by the driving of adjacent piles.

(B) Timber Piles

Store and handle timber piles by methods that do not damage the pile. Take care to avoid breaking the surface of treated piles. Do not use cant-hooks, dogs, or pike-poles. Treat cuts or breaks in the surface of treated piles in an approved manner.

Cut off the tops of all piles at the elevation shown on the plans. Except where a cast-in-place concrete cap or footing is constructed, cut off piles to a plane that provides true bearing on every pile without the use of shims. Withdraw any pile damaged during driving operations, driven out of its proper location or below the cut-off grade and replace with a new pile, or otherwise correct as directed by the Engineer.

Thoroughly brush-coat the sawn surface of all timber piles not encased in concrete with 3 applications of approved preservative treatment and then cover with a coat of hot roofing pitch or other approved hot bituminous material. Place a sheet of galvanized iron or aluminum upon each pile head, bend it down over the sides of the pile, neatly trim and firmly secure to the pile with large headed galvanized roofing nails. Use sheets of iron that are 24 gauge and 24" by 24" in size. If using aluminum, use the same size as specified for galvanized iron sheets with a minimum thickness of 0.032".

(C) Prestressed Concrete Piles

Handle, transport, and store prestressed concrete piles by methods that do not damage the pile and support the piles at the pick-up points shown on the plans or along their full length. Replace piles damaged in handling or driving unless they are repaired to an acceptable condition.

When driving or cutting off piles below the elevation shown on the plans, build up the pile section to the plan elevation as shown on the plans unless otherwise directed by the Engineer.

Cut off piles not driven to grade perpendicular to the axis of the pile by means that do not result in spalling or other damage to the pile. Use steel pile tips with prestressed concrete piles when shown on the plans. Use pile splicers for splicing steel pile tips. Contact the Materials and Tests Unit for a list of approved pile splicers. Submit pile splicer specifications with the manufacturer’s attachment detail to the Engineer for approval before installation.

(D) Steel Piles

Handle and store steel piles by methods that do not damage the pile. Store the piles above ground upon platforms, blocks, or other supports and keep the piles free from dirt, grease, and other foreign matter, and protect insofar as is practicable from corrosion. Do not damage coatings on steel piles. Protect coatings when driving piles through templates in an approved manner.

When shown on the plans, galvanize steel piles in accordance with Section 1076. Prepare the pile surface and provide materials in accordance with the applicable portions of this section.

Use pile points for steel piles when shown on the plans or as directed by the Engineer. Contact the Materials and Tests Unit for a list of approved pile points. Weld pile points to piles in accordance with the manufacturers' details as approved by the Engineer. The minimum weld length is twice the width of the flange.

Furnish plates for pipe piles when shown on the plans or as directed by the Engineer. Weld plates to the bottom of pipe piles as shown on the plans. Use pipe pile plates with a thickness as shown on the plans and that meets the requirements of ASTM A709, Grade 50.

Cut off piles at the required elevations along a plane normal to the axis of the pile. Use approved methods for cutting off piles.

Use welded butt splices for steel piles as shown on the plans. Weld in accordance with the requirements of Article 1072-20. Do not use more than 3 pieces (2 splices) of steel pile in making up one full-length pile.

(E) Redriving Piles

Once the required pile embedment has been achieved, the Contractor may choose to or the Engineer may require restriking or redriving piles. If the Contractor chooses to stop driving and then restrike or redrive piles, no payment will be made for restrikes or redrives. If the Engineer requires the Contractor to stop driving and then restrike or redrive piles, the payment will be made in accordance with Article 450-9. When the Engineer requires restrikes or redrives, the Engineer will determine the time to wait after stopping driving and the number of restrikes or redrives. However, the maximum number of restrikes or redrives per pile during any 48 hour period will not exceed three. The minimum time separation between redrives required by the Engineer is 4 hours.

Use the same approved pile driving methods, equipment and compressed pile cushion from the previous drive to restrike or redrive the pile unless the cushion is unacceptable due to deterioration, in which case use another acceptable cushion. Do not use a cold diesel hammer for a restrike or redrive, unless in the opinion of the Engineer, it is impractical to do otherwise. In general, warm up the hammer by applying at least 20 blows to a previously driven pile or timber mats on the ground.

450-8 PENETRATION AND WAVE EQUATION

When no tip elevation is shown on the plans, drive piles to the required bearing capacity and a penetration of at least 10 feet into natural ground unless otherwise directed by the Engineer. When a tip elevation is shown on the plans, drive piles to the required bearing capacity and the specified tip elevation. When noted on the plans, drive piles to additional capacity to account for downdrag or negative skin friction and scour.

Natural ground within an area of new embankment is defined as the bottom of the embankment or bottom of footing on piles, whichever is lower.

The Engineer will use the wave equation analysis to evaluate the suitability of the proposed pile driving methods and equipment to evaluate pile driving stresses and estimate the driving resistance in order to achieve the required bearing capacity. The required driving resistance in blows per foot or any equivalent set, is based upon the bearing capacity shown on the plans with a minimum safety factor of 2 plus any additional capacity to account for downdrag or negative skin friction and scour, when applicable. The Engineer will provide the required driving resistance based upon the wave equation analysis and pile driving analyzer results, if applicable, using the approved pile driving methods and equipment.

Stop driving piles when practical refusal is reached, unless otherwise directed by the Engineer. Practical refusal is defined as 180 blows per foot or any equivalent set.

450-9 MEASUREMENT AND PAYMENT

Piles (Treated Timber Piles, _____ Inch Prestressed Concrete Piles, _____ Steel Piles or _____ Galvanized 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.

For prestressed concrete piles that are built up, the quantity of piles to be paid for will also include the actual number of linear feet added to the original pile length by the build-up. Steel pile tips are not included in the quantity of prestressed concrete piles. No payment will be made for steel pile tips or pile splicers and any associated hardware or welding. The cost for these items will be considered incidental to the cost of the prestressed concrete pile.

Pile points will be measured and paid for per each for the actual number of pile points incorporated into the completed and accepted structure.

Pipe pile plates will be measured and paid for per each for the actual number of plates incorporated into the completed and accepted structure.

Pile redrives will be measured and paid for per each as the actual number of restrikes or redrives required by the Engineer. No payment will be made for restrikes or redrives when the Contractor chooses to restrike or redrive piles.

No payment will be made for any defective or rejected piles or any piles driven for falsework, bracing, or temporary work bridges.

The prices and payments will be full compensation for all items required to provide bearing piles including but not limited to those items contained in Article 450-1.

Payment will be made under:

Pay Item	Pay Unit
Treated Timber Piles	Linear Foot
_____ inch Prestressed Concrete Piles	Linear Foot
_____ Steel Piles	Linear Foot
_____ Galvanized Steel Piles	Linear Foot
Steel Pile Points	Each
Pipe Pile Plates	Each
Pile Redrives	Each

SECTION 452
SHEET PILE RETAINING WALLS

452-1 DESCRIPTION

Construct permanent sheet pile retaining walls of sheet piling and concrete coping, if required, as shown on the plans and as directed by the Engineer. This section only applies to sheet pile retaining walls that are left in place so that they become part of the completed work. Provide and drive sheet piles; furnish collars, hardware, and all other materials and equipment; cut off sheet piles as necessary; furnish and place temporary bracing and reinforcing steel; construct, form, and finish concrete coping; seal joints; place and compact backfill; remove any obstructions; and remove, replace, and correct sheet piles as necessary.

452-2 MATERIALS

Refer to Division 10:

Item	Section
Steel and Prestressed Concrete Sheet Piles	1084
Portland Cement Concrete	1000
Curing Agents	1026
Joint Fillers	1028-1
Joint Sealers	1028-4
Reinforcing Steel	1070-1, 1070-2

452-3 DRIVING EQUIPMENT

Submit the proposed sheet pile driving methods and equipment to the Engineer. Submit this information for approval at least 20 working days before driving sheet piles. Drive sheet piles with approved driving equipment using steam, air, or diesel hammers. Use pile driving hammers that do not overstress the sheet piles during driving.

452-4 ACCURACY OF DRIVING

Drive sheet piles to a tolerance of not more than 1/8" per foot from the vertical. Horizontally, keep the sheet piles within 3" of the plan location longitudinally and transversely.

452-5 CONSTRUCTION REQUIREMENTS

(A) General

Unless otherwise approved or directed by the Engineer, do not drive sheet piles within 50 feet of cast-in-place concrete until the concrete attains an age of at least 3 curing days. When approved by the Engineer, the Contractor may use vibratory hammers to install portions of steel sheet piles. The Engineer will determine the allowable depth of sheet pile installation with the vibratory hammer. Do not use vibratory hammers to install prestressed concrete sheet piles.

The Engineer will inspect the capblock before beginning each pile driving project and periodically throughout the duration of the project, depending on driving conditions, as determined by the Engineer. Expose the hammer cushion for inspection as directed by the Engineer. Replace or repair any hammer cushion that is less than 25% of the original thickness.

Do not exceed the allowable pile driving stresses during the entire driving time. Allowable pile driving stresses are defined in the *AASHTO Standard Specifications for Highway Bridges*. Drive piles to the required tip elevation or penetration into natural ground, whichever is lower, in a continuous operation unless stopped due to exceeding the maximum blow count or allowable pile driving stresses, insufficient sheet pile length, or other reasons approved by the Engineer.

Use a pile cushion made of pine plywood for driving prestressed concrete sheet piles. Replace the pile cushion if, during the driving of any sheet pile, the cushion is either compressed more than one-half the original thickness or begins to burn. When using a pile cushion, provide a new cushion for each sheet pile unless approved otherwise by the Engineer.

(B) Prestressed Concrete Sheet Piles

Handle, transport, and store prestressed concrete sheet piles by methods that do not damage the pile. Support the sheet piles while handling, transporting, and storing as shown on the plans or along their full length. Replace sheet piles damaged in handling or driving unless they are repaired to an acceptable condition.

Cut off concrete sheet piles not driven to grade by means that do not result in spalling or other damage to the sheet pile.

(C) Steel Sheet Piles

Handle and store steel sheet piles by methods that do not damage the pile. Store the sheet piles above ground upon platforms, blocking, or other supports. Keep the sheet piles free from dirt, grease, and other foreign matter, and protect them insofar, as is practicable from corrosion.

Cut off sheet piles with approved methods at the required elevations.

(D) Sheet Pile Penetration:

Install sheet piles such that the tips of the sheet piles penetrate to the tip elevations shown on the plans or as directed by the Engineer.

(E) Concrete Coping:

When concrete coping is required as shown on the plans, place reinforcing steel and construct cast-in-place concrete coping in accordance with Section 825. Extend coping 6" above the elevation where the grade intersects the back of the wall unless otherwise required by the plans or as directed by the Engineer. If required, insert sleeves for fence posts in the top of coping in accordance with Section 866. Use Class A concrete and provide an ordinary surface finish. Grooved contraction joints are required every 10 ft and expansion joints are required every 30 ft along the coping. If the grade behind the wall slopes towards the wall, seal the joint between the coping and the asphalt or concrete with joint sealer.

Remove forms any time after 3 hours if the concrete is sufficiently set to permit form removal without damaging the coping.

(F) Backfilling:

When concrete coping is required as shown on the plans, do not backfill behind sheet pile retaining walls until the concrete develops a minimum compressive strength of 3,000 psi.

Use approved material for backfill that is free from large or frozen lumps, wood, or other undesirable material. Where it is necessary to provide backfill material from sources other than excavated areas or borrow sources in connection with this contract, payment for furnishing and hauling such backfill material will be made as provided in Article 104-7 for extra work. Placing and compacting such backfill is not considered extra work and will be considered incidental to the cost of the sheet pile retaining wall.

Compact backfill in accordance with Subarticle 235-4(C). Place backfill within 3 ft of the back of the wall with hand operated compaction equipment. Do not operate heavy earth moving equipment within 10 ft of the back of the wall.

452-7 MEASUREMENT AND PAYMENT

Sheet pile retaining wall will be measured and paid as the actual number of square feet of exposed face area incorporated into the completed and accepted wall. The wall height is measured as the difference between the top and bottom of the wall. The bottom of the wall is defined as the point where the finished grade intersects the front of the wall. The top of the wall is defined as the top of coping or bottom of cap elevation.

The price and payment will be full compensation for all items required to provide sheet pile retaining walls including but not limited to those items contained in Article 452-1.

Payment will be made under:

Pay Item	Pay Unit
___Steel Pile Retaining Walls	Square Foot

SECTION 453
GRAVITY RETAINING WALLS

453-1 DESCRIPTION

Construct gravity retaining walls of cast-in-place reinforced concrete and a brick veneer, if required, in accordance with the Structure Standard Drawings for gravity retaining walls and as directed by the Engineer. Furnish and place concrete, reinforcing steel, brick masonry and ties, joint fillers and sealers, curing agents, and all other materials and equipment; erect and remove all falsework and forms; protect concrete in wind, rain, low humidity, high temperatures, or other unfavorable weather; construct joints and weep holes; finish and cure concrete; protect concrete from rust stains; place stone drains and subdrain fine aggregate; place and compact backfill; and excavate for walls.

453-2 MATERIALS

Refer to Division 10:

Item	Section
Portland Cement Concrete	1000
Curing Agents	1026
Joint Fillers	1028-1
Joint Sealers	1028-4
Reinforcing Steel	1070-1, & 1070-2
Subdrain Fine Aggregate	1044-1
Stone, #78M	1005
Brick	1040-1
Mortar	1040-8

453-3 CONSTRUCTION REQUIREMENTS

Excavate as necessary for gravity retaining walls. Notify the Engineer when foundation excavation is complete. Do not place any concrete until obtaining approval of the excavation depth and the character of the foundation material. Where foundation material is found to be unacceptable, undercut the foundation material and backfill with an approved select material as directed by the Engineer.

Place reinforcing steel and construct cast-in-place concrete in accordance with Section 420. Construct 3" diameter weep holes on 10 ft centers along the wall. Exit weep holes just above finished grade and slope holes on a 1" per foot slope through the wall so that water drains out of the front of the wall. Extend the top of wall 6" above the elevation where the grade intersects the back of the wall unless otherwise required by the plans or as directed by the Engineer.

If required, insert sleeves for fence posts in the top of wall in accordance with Section 866. Use Class A concrete and provide a Class 1 surface finish for all exposed surfaces. Grooved contraction joints are required every 10 ft and expansion joints are required every 30 ft. along the wall. Remove forms any time after 3 hours if the concrete is sufficiently set to permit form removal without damaging the wall.

If the grade behind the wall slopes towards the wall, seal the joint between the wall and the asphalt or concrete with joint sealer. If a concrete paved ditch is required behind the wall, the sloping backwall of the gravity retaining wall forms half the concrete paved ditch.

If a brick veneer is required as shown on the plans, construct brick masonry in accordance with Section 830. Anchor brick veneer with approved brick to concrete type anchors according to the manufacturers' specifications with a minimum vertical spacing of 16" and a minimum horizontal spacing of 32" with each row staggered 16" from the row of anchors above and below.

Place a stone drain consisting of one cubic foot of #78M stone contained in a bag of porous fabric at each weep hole. Place subdrain fine aggregate beneath, around, and over the stone drain so that the stone drain is covered by a layer of subdrain fine aggregate at least 1 ft. thick. Place a horizontal drain of subdrain fine aggregate at least 1 ft square in cross section to connect all stone drains.

Do not backfill behind gravity retaining walls until the concrete develops a minimum compressive strength of 3,000 psi. Use approved material for backfill that is free from large or frozen lumps, wood or other undesirable material. Where it is necessary to provide backfill material from sources other than excavated areas or borrow sources in connection with this contract, payment for furnishing and hauling such backfill material will be made as provided in Article 104-7 for extra work. Placing and compacting such backfill is not considered extra work and will be considered incidental to the cost of the gravity retaining wall.

Compact granular backfill in accordance with Subarticle 235-4(C). Place backfill within 3 ft. of the back of the wall with hand operated compaction equipment. Do not operate heavy earth moving equipment within 10 ft. of the back of the wall.

453-4 MEASUREMENT AND PAYMENT

Gravity retaining walls will be measured and paid for as the actual number of square feet of exposed face area incorporated into the completed and accepted wall. The wall height is measured as the difference between the top and bottom of wall. The bottom of wall is defined as the point where the finished grade intersects the front of the wall. The top of wall is defined as the top elevation of the completed wall including any height from the brick veneer, if applicable. If a concrete paved ditch is required behind the wall, no payment will be made for the portion of the ditch formed by the sloping backwall of the gravity retaining wall.

The price and payment will be full compensation for all items required to provide gravity retaining walls including but not limited to those items contained in Article 453-1.

Payment will be made under:

Pay Item	Pay Unit
Gravity Retaining Walls	Square foot

SECTION 454
WATERPROOFING AND DAMPPROOFING

454-1 DESCRIPTION

Waterproof or dampproof concrete surfaces in accordance with the requirements of these Specifications for the particular method of waterproofing or dampproofing called for on the plans. Furnish and apply all asphalt, tar, fabric, asphalt plank, and any other materials.

454-2 MATERIALS

Refer to Division 10:

Item	Section
Asphalt Primer	1020-9(A)
Asphalt Binder	1020-9(B)
Tar	1020-9(C)
Woven Cotton Fabric	1020-9(D)

454-3 METHOD A WATERPROOFING

(A) General

Method A waterproofing consists of one coat of asphalt primer, and 3 mop coats of hot asphalt cement with 2 layers of cotton fabric alternating between the mop coats.

(B) Preparation of Surface

Ensure that concrete surfaces are dry, reasonably smooth, and free from projections or holes which are capable of puncturing the membrane. Immediately before applying the waterproofing, thoroughly clean the surface of dust and loose materials.

Make sure that the concrete is at least 14 days old for Class A concrete, at least 10 days old for Class AA Concrete, or at least 7 days old for high early strength concrete, before beginning waterproofing. Do not waterproof in wet weather nor when the temperature is below 35°F, without permission.

(C) Application

Give waterproofed surfaces a thorough coat of asphalt primer, and allow it to set thoroughly before applying the first mop coat. Heat the asphalt cement for the mop coat to a temperature of not less than 300°F and frequently stir to avoid local overheating. Equip the heating kettles with thermometers.

Begin the waterproofing at the low point of the surface.

Use a half width first strip of fabric; and a full width second strip. Lap the full width of the first strip. Make the third and each succeeding strip full width and lap so that there are 2 layers of fabric at all points with laps not less than 2" wide. Make sure that the end laps are at least 12".

Beginning at the low point of the surface, mop a section about 20" wide and the full length of the surface with hot asphalt cement. Immediately roll the first strip of fabric into the asphalt cement and press into place to eliminate all air bubbles and to provide a firm bond to the surface. Mop this strip and an adjacent section of the surface of a width equal to slightly more than half the width of the fabric with hot asphalt binder and roll a full width of the fabric into this cement, completely covering the first strip, and press into place. Mop this second strip and an adjacent section of the concrete surface with hot asphalt cement and place the third strip of fabric to lap the first strip not less than 2". Continue this process until the entire surface is covered, each strip of fabric lapping at least 2" over the second preceding strip. Give the entire surface a final mopping of hot asphalt cement.

Mop on concrete to completely cover the surface sufficiently heavy on cloth to completely conceal the weave. Use at least 12 gallons of asphalt on horizontal surfaces for each 100 square feet of finished work, and at least 15 gallons on vertical surfaces. Perform the work so that, at the close of a day's work, all laid cloth receives the final mopping of asphalt. Thoroughly seal down all laps.

(D) Special Requirements

At the edges of the membrane and at any points punctured by such appurtenances as drains or pipes, make suitable provisions to prevent water from getting between the waterproofing and the waterproofed surface.

Place all membrane flashing at curbs and against girders, spandrel walls, etc., with separate sheets of membrane lapping the main membrane not less than 12". Closely seal flashing with either a metal counter-flashing or by embedding the upper edges of the flashing in a groove poured full of joint filler.

Provide expansion joints, both horizontal and vertical, with water stops and premolded joint filler as called for on the plans. Seal expansion joints in the face

adjacent to the membrane bituminous material. Carry the membrane continuously across all expansion joints.

At the ends of the structure carry the membrane well down on the abutments and make suitable provisions for all movement.

(E) Repairs

Repair any damage that occurs as directed. Repair by patching when permitted. Extend the first ply of the patch at least 12" beyond the outermost damaged portion of the membrane and extend the second ply at least 3" beyond the first.

(F) Backfilling

Do not backfill without permission and until the final mop coat thoroughly hardens. Place backfill in such a manner that the waterproofing is not damaged.

454-4 METHOD B DAMPPROOFING

(A) General

Method B dampproofing consists of 2 coats of tar, Grade RT-6.

(B) Preparation of Surface

Make sure the surfaces are dry. Immediately before applying the first dampproofing coat, thoroughly clean the surfaces of dust and loose materials. Permit the concrete to cure for a period of at least 14 days for Class A concrete, at least 10 days for Class AA concrete, or 7 days for high early strength concrete, before dampproofing.

(C) Application

Give the concrete surfaces 2 applications tar, Grade RT-6. Apply the tar by means of suitable brushes to secure uniform and thorough applications. Do not apply the second coat of tar until the first coat thoroughly sets. Do not apply dampproofing during any time that the surface is exposed to any moisture. Make sure that the temperature of the tar is such that uniform and thorough application is obtained. Do not backfill until the second coat thoroughly sets.

454-5 MEASUREMENT AND PAYMENT

Method ___waterproofing will be measured and paid as the actual number of square yards of surface that is waterproofed. In measuring this quantity, measurement is made along the actual surface that is to be waterproofed before the waterproofing is applied.

Method ___dampproofing will be measured and paid as the actual number of square yards of surface that is dampproofed. In measuring this quantity, measurement is made along the actual surface that is to be dampproofed before the dampproofing is applied.

These prices and payments will be full compensation for all items required to waterproof and dampproof including but not limited to those items contained in Article 454-1.

Payment will be made under:

Pay Item	Pay Unit
Method _____ Waterproofing	Square Yard
Method _____ Dampproofing	Square Yard

SECTION 460
BRIDGE RAILING

460-1 DESCRIPTION

Furnish and place metal, pipe, or concrete barrier bridge railing in accordance with the requirements of these Specifications and as shown on the plans. Furnish posts, rail bars, pipe fittings, hardware, paint, barrier delineators, concrete, reinforcing steel, admixtures, forms, falsework and all other materials; galvanize; paint; fabricate and erect rail; and place, finish, and cure concrete.

460-2 MATERIALS

Refer to Division 10:

Item	Section
Portland Cement Concrete	1000
Retroreflective Sheeting	1070-2
Aluminum Rail	1074-5
Galvanized Steel Rail	1074-5
Pipe Rail	1074-6
Paint	1080
Barrier Delineators	1088-2
Epoxy Coated Reinforcing Steel	1070-8

460-3 CONSTRUCTION METHODS

Adhere to the construction load limitations of Article 420-20 while placing concrete for all bridge rails.

(A) Metal Rail

Use either aluminum or galvanized steel rail, but use the same material on all structures on the project on which metal rail is required.

Use shims if necessary to obtain correct post alignment.

Drive aluminum rivets cold. Thoroughly coat the base of aluminum rail post, closure plates, shims, or any other aluminum surface in contact with concrete with an approved aluminum impregnated caulking compound.

(B) Pipe Rail

Give galvanized pipe rail one field coat of organic zinc repair paint, of minimum wet thickness of 1.5 mils, after erection in accordance with the requirements of Section 442 unless otherwise required in the contract.

(C) Concrete Barrier Rails

This Subarticle applies to the construction of concrete barrier rail, median barrier rail and concrete parapet, referred to collectively as concrete barrier rails.

Plans for the concrete barrier rails are detailed for slip-formed cast-in-place concrete. Unless otherwise noted, construct concrete barrier rails detailed on the plans using conventional forms or by slip-forming using an approved self-propelled extrusion machine. Except as noted herein, construct in accordance with the requirements of Section 420.

Construct joints in the barrier rails at the locations and of the type shown on the plans.

Construct concrete barrier rails to the shape, line, grade, and dimensions shown on the plans except that when slip-forming rails, either radius or chamfer the corners. Check slip-formed rail concrete directly behind the extrusion machine using successive overlapping applications of the 10-foot straightedge. Correct high and low areas while the concrete is still workable. Limit horizontal and vertical deviation from plan line and grade to no more than 1/4" in 10 feet.

Provide sufficient internal vibrators to consolidate the concrete along the faces of forms and adjacent to joints. Consolidate the concrete by internal vibration in one pass of the extrusion machine. Produce a dense and homogeneous barrier free of voids and honeycomb with minimum hand finishing. Coordinate concrete delivery and placement to provide uniform progress while minimizing stopping and starting of the extrusion machine.

When plans require horizontal deck drains through the barrier rails, use drain couplings with slip-formed rails.

Correct all exposed surfaces that are not satisfactory to the Engineer as to uniformity of color and texture or because of excessive patching as required. Give the roadway face of barrier rails constructed using conventional forms a Class 2 surface finish in accordance with Subarticle 420-17(F). Use a broom finish on the roadway face of slip-formed barrier rails.

Provide barrier rail delineators in accordance with Section 854.

460-4 MEASUREMENT AND PAYMENT

____ *Bar Metal Rail* will be measured and paid for as the actual number of linear feet of metal rail, measured along the top bar of the rail, that is completed and accepted.

__" *Galvanized Steel Pipe Rail* will be measured and paid for as the actual number of linear feet of pipe rail, measured along the top pipe of the installed pipe rail, that is completed and accepted.

Concrete Barrier Rail will be measured and paid for as the number of linear feet of concrete barrier rail provided on the plans.

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

____ *x* ____ *Concrete Parapet* will be measured and paid for as the number of linear feet of concrete parapet provided on the plans.

Construct slope protection under the ends of bridges or at other locations in accordance with details shown in the contract. Excavate and backfill; and furnish and place concrete, reinforcement, and other materials. Unless otherwise noted on the plans, use cast-in-place reinforced concrete.

There will be no direct payment for bridge rail delineators as they are incidental to other pay items in this Specifications.

These prices and payments will be full compensation for all items required to provide bridge railing including but not limited to those items contained in Article 460-1.

Payment will be made under:

Pay Item	**Pay Unit**
____ Bar Metal Rail	Linear Foot
__" Galvanized Steel Pipe Rail	Linear Foot
Concrete Barrier Rail	Linear Foot
Concrete Median Barrier	Linear Foot
____ x ____ Concrete Parapet	Linear Foot

SECTION 462
SLOPE PROTECTION

462-1 DESCRIPTION

Construct slope protection under the ends of bridges or at other locations in accordance with details shown in the contract. Excavate and backfill; and furnish and place concrete, reinforcement, and other materials. Unless otherwise noted on the plans, use cast-in-place reinforced concrete.

462-2 MATERIALS

Refer to Division 10.

Item	**Section**
Portland Cement Concrete	1000
Curing Agents	1026
Joint Fillers	1028-1
Wire Mesh Reinforcement	1070-3
Grout	1040-9

462-3 CONSTRUCTION METHODS

Immediately before placing the paving, properly shape and firmly compact the slope so that it conforms to the required lines and grades.

Construct cast-in-place concrete slope protection in accordance with Section 420, except as otherwise provided herein. Use Class B concrete. Furnish and place reinforcement as shown on the plans and in accordance with the requirements of Section 425. After placing the concrete for one section, strike it off to plan grade and finish to a dense and uniform surface.

Provide a reasonably smooth and uniform surface for the finished slope protection that does not vary more than 1/2" in a distance of 10 feet.

Do not place backfill adjacent to cast-in-place slope protection at any one end bent until each individual section of paving at the end bent cures for 3 or more curing days as defined in Subarticle 420-15(A). However, place backfill no later than 5 calendar days after the last section of concrete paving placed at the end bent cures for 3 curing days. Compact all backfill to a degree comparable to the adjacent undisturbed material.

462-4 MEASUREMENT AND MEASUREMENT

__" Slope protection will be measured and paid for as the actual number of square yards of slope protection, measured along the top surface of the paving, which is completed and accepted.

The price and payment will be full compensation for all items required to provide slope protection including but not limited to those items contained in Article 462-1.

Payment will be made under:

Pay Item	Pay Unit
__" Slope Protection	Square Yard

DIVISION 5
SUBGRADE, BASES, AND SHOULDERS

SECTION 500
FINE GRADING SUBGRADE, SHOULDERS AND DITCHES

500-1 DESCRIPTION

Perform the work covered by this section including but not limited to preparing, grading, shaping, and compacting either an unstabilized or stabilized roadbed to a condition suitable for placement of base course, pavement, and shoulders. Clean, shape, and maintain roadway ditches; strip existing vegetation; and place and compact in accordance with Sections 235 and 560 all materials resulting from the shaping operation. Stockpile surplus material for the construction of shoulders and dispose of any necessary surplus stockpile material as waste. Perform this work on all portions of the project which will be paved under the contract.

On those portions of the roadway where there is no pavement to be placed under the contract, perform the work covered by this section under the requirements of Section 225 or Section 230, depending upon the source of the material. The provisions of this section will not be applicable to such work.

500-2 CONSTRUCTION METHODS

(A) General

Shape the roadway to conform to the lines, grades, and typical sections shown on the plans. Strip all existing vegetation from the ground surface wherever shaping of the roadway is to be done. Utilize all suitable surplus material in the construction of the roadway or stockpile for use in shoulder construction. Dispose of surplus material in excess of that needed for roadway or shoulder construction as waste. Obtain additional material, if needed, from roadway excavation or borrow sources.

Remove all unsuitable material, boulders, and all vegetative matter and replace with suitable material. Obtain suitable material, when not available from the shaping or fine grading operation, from roadway excavation or borrow sources.

Clean, reshape, and maintain roadway ditches in a satisfactory condition until final acceptance of the project.

Conduct operations in such a manner as to avoid damage to any previously constructed structures and facilities.

(B) Preparation of Subgrade

Shape the subgrade to the lines, grades, and typical sections shown on the plans. Where the Engineer directs that areas of the subgrade are to be stabilized with aggregate, the subgrade surface in such areas may, subject to the approval of the Engineer, be left uniformly below grade to provide for the addition of the stabilizer material.

Store or stockpile material excavated in preparing the subgrade in such a manner as to not interfere with proper drainage or any subsequent operations of stabilization, placing base, or placing pavement.

(C) Compaction of Subgrade

Compact all material to a depth of 8" below the finished surface of the subgrade to a density equal to at least 100% of that obtained by compacting a sample of the material in accordance with AASHTO T99 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit.

Compact the subgrade at a moisture content which is approximately that required to produce the maximum density indicated by the above test method. Dry or add moisture to the subgrade when required to provide a uniformly compacted and acceptable subgrade.

Where the subgrade is to be stabilized with lime, aggregate, or cement, the above density requirements will not apply prior to the incorporation of the stabilizing material, however, perform compaction in accordance with the requirements of Article 501-10, 510-3, or 542-9, as appropriate.

500-3 TOLERANCES

A tolerance of plus or minus 1/2" from the established grade will be permitted after the subgrade has been graded to a uniform surface.

Perform the grading operation such that the maximum difference between the established grade and the graded subgrade within any 100-foot section is 1/2".

500-4 PROTECTION OF SUBGRADE

Provide and maintain ditches and drains as may be necessary to satisfactory drain the subgrade. Where previously approved subgrade is damaged by natural causes, by hauling equipment, or by other traffic, restore the subgrade to the required lines, grades, and typical sections and to the required density at no additional cost to the Department.

500-5 Measurement and Payment

Fine Grading will be paid for at the contract lump sum price. Such lump sum price will be full payment for all material excavated to a depth of 0.4 foot below the existing graded surface.

Any material which has been excavated from the subgrade at the depth greater than 0.4 foot below the existing graded surface will be considered unclassified excavation and will be paid for as provided in Article 225-8.

As an exception to the above, on those areas in which the Contractor is responsible for constructing the embankment on which the subgrade is located, no payment will be made for that excavation that may be necessary to bring the grade to the established subgrade elevation and typical section. Incorporate such surplus material into the project at no additional cost to the Department.

When sufficient material is not available from the fine grading operation to complete the work of fine grading, additional material will be paid for as provided in Article 225-8 for Unclassified Excavation or in Article 230-6 for Borrow Excavation, depending on the source of material.

Surplus material stockpiled for shoulder construction and incorporated into the work will be paid for as provided in Article 560-5 for Shoulder Borrow. No payment will be made for the removal and disposal of any surplus material remaining in the stockpile after the shoulders have been completed.

Payment will be made under:

Pay Item	Pay Unit
Fine Grading	Lump Sum

SECTION 501
LIME-TREATED SOIL

501-1 DESCRIPTION

Perform the work covered by this section including but not limited to treating the subgrade, embankment, natural ground, or existing pavement structure by adding water and lime in the form specified herein, mixing, shaping, compacting, and finishing the mixture to the required density. Prepare the soil layer to be stabilized; haul, proportion, spread, and mix the materials within the depth range as shown on plans; manipulate, compact, and finish the lime treated soil; correct, repair, and maintain the lime treated soil; and apply a sand seal in accordance with the requirements of Article 501-3. Construct the work in conformity with the typical sections, lines, and grades shown on the plan, and in accordance with these Specifications.

501-2 MATERIALS

Refer to Division 10

Item	Section
Lime	1052-3
Water	1024-4

Use soil material which consists of material upon which the pavement is to be placed, existing material upon which the embankment is to be placed, approved borrow material, or a combination of these materials proportioned as directed. Remove all vegetation, roots, or other objectionable matter from the soil, as well as all aggregate or stone larger than 2" for the full depth to be treated.

501-3 LIMITATIONS

Do not perform lime stabilization when the air temperature is below 45°F or in the period from November 1 to March 15 except by written permission. Do not mix the lime with frozen soils or when the soils contain frost. Apply lime to such areas as can be initially mixed and sealed during the day of application. Do not apply lime when wind conditions,

are such that blowing lime becomes hazardous to traffic, workers, or adjacent property owners, or when excessive loss of lime may occur.

Do not construct lime-treated soil that will not be covered with a layer of pavement or base by December 1 of that same calendar year. The Engineer may suspend the lime stabilization operations in writing when he determines that the Contractor will not cover the completed stabilization by December 1 as specified above. Failure of the Contractor to cover the lime treated soil as required above will result in the Engineer notifying the Contractor in writing to cover the lime treated soil with a sand seal. Apply the sand seal in accordance with the requirements of Section 660 except that Articles 660-3, 660-11, and 660-12 will not apply. Perform this work at no cost to the Department. In the event the Contractor fails to apply the sand seal within 72 hours after receipt of such notice, the Engineer may proceed to have such work performed by other forces and equipment. The cost of such work performed by other forces will be deducted from monies due or to become due to the Contractor. The application of the sand seal by the Contractor or other forces will in no way relieve the Contractor of the responsibility to maintain or repair the damaged stabilization, no matter what the cause of damage, at no cost to the Department.

501-4 EQUIPMENT

(A) General

Use any combination of machines and equipment to produce the required results that meet the approval of the Engineer. Correct any leakage of fluids and/or materials promptly or the Engineer may order such equipment removed and replaced with satisfactory equipment. Comply with Article 107-22 with respect to operation of equipment and prevent damage to the base while applying water, curing seal and blotting sand.

(B) Lime Spreaders

Spread lime at the required rate by methods and equipment, which have been approved.

(C) Water Distribution Equipment

Add water to the soil with a pressure distributor or other suitable equipment capable of uniformly distributing the required amount.

(D) Mixers

Perform mixing with a self-propelled rotary mixer, except that disc harrows, motor graders, and other equipment may be used only to supplement the mixing done by the rotary mixer.

Use mixing equipment capable of mixing to a compacted depth of at least 10".

(E) Compaction Equipment

Use compaction equipment that is self-propelled. Perform finish rolling with a pneumatic tired roller, or as permitted, a smooth, steel-wheel roller, or a combination of both types.

(F) Scarifying Equipment

Use a grader-scarifier for the initial scarification of the soil. Use equipment capable of scarifying to the full depth of the stabilized treatment. When required, use a weeder, spiketooth harrow, or nail drag, followed by a broom drag to scarify during finishing operations.

501-5 PROTECTION AND SAFETY

Take necessary precautions to protect personnel from dust created by the lime application and mixing operation to include eye protection, dust masks and appropriate training.

501-6 PREPARATION OF ROADBED

Prior to the addition of any lime to the soil, grade and shape the area to be stabilized in close conformity to the typical sections, lines, and grades shown on the plans. Remove all materials such as roots, turf, and aggregate larger than 2".

501-7 SCARIFYING

When required by the method of application, scarify the soil to the required depth and width and then partially pulverize by making one pass through the area with a pulverizing rotary mixer. Delete the pulverizing portion of the scarifying operation in areas where the soil types or conditions make pulverizing with a rotary mixer impractical.

501-8 APPLICATION OF LIME

(A) General

When the Contractor has brought the soil layer to the elevation required by the plans, the Engineer will sample the soil to be stabilized in order to determine the quantity of lime to be incorporated. Allow 24 calendar days for the Engineer to perform the required sampling, testing, and final design of the lime stabilization.

Spread lime or lime slurry only on an area of such size that all primary mixing operations can be completed in the same day during daylight hours except where the work is to be done at night as required by the contract.

Incorporate the lime or lime slurry into the soil mixture at the rates determined by the Engineer. Distribute the lime at the uniform rate and in such a manner as to reduce the scattering by the wind to a minimum. Mix the lime into the soil within 2 hours after application.

No equipment, except that used in spreading, slaking, and mixing, will be allowed to pass over the freshly spread lime until it is mixed with the soil.

(B) Slurry Method

Do not add lime slurry to the soil when the moisture content exceeds 2% above optimum moisture. Aerate soil having a moisture content higher than 2% above optimum or allow to dry naturally until it contains no more than this percentage of moisture. The optimum moisture will be determined by the Engineer.

Mix hydrated lime applied by this method with water in approved agitating equipment and apply to the soil to be treated as a thin water suspension or slurry.

When quicklime is used to produce the slurry, use equipment specifically manufactured for the slaking of quicklime. Use distributing equipment that provides continuous agitation of the slurry from the slurry production site until the slurry is applied to the soil. Proportion the lime so that the "Dry Solids Content" is at least 30% by weight.

Split the lime application into approximately 2 equal applications with the first being partially mixed into the soil to a minimum depth of 3" prior to applying the second application.

(C) Quicklime

Do not add dry quicklime to the soil when the moisture content exceeds 4% above optimum moisture. Aerate soil having a moisture content higher than 4% above optimum or allow to dry naturally until it contains no more than this percentage of moisture. The optimum moisture will be determined by the Engineer.

Where the "Bottom-Dump" method of application is used, omit the preliminary scarification of the soil surface. Apply the quicklime by slowly driving the tanker truck over the coverage area with the bottom discharge valves open creating a windrow of quicklime.

Repeat the process until the tanker is empty in order to provide a minimum of 3, for 24 ft. roadway, reasonably uniform and equally spaced windrows over the area being stabilized. The number of windrows required will depend on the width of the section being stabilized and will be stipulated by the Engineer.

Carefully spread the windrows of quicklime with a motor grader into an equal depth layer over the entire area to be stabilized.

After the lime has been spread, follow with a sprinkling of water to slake the lime. After a complete slaking of the lime, thoroughly mix the lime with the soil. The Engineer may direct that the lime first be mixed into the soil followed by sprinkling and additional mixing to ensure complete slaking of the lime throughout the layer to be stabilized.

(D) Hydrated Lime

Use hydrated lime only with written permission and do not add to the soil when the moisture content exceeds 6% above optimum moisture.

501-9 MIXING

(A) Primary Mixing

Immediately after the lime has been spread (and slaked, if required), mix the lime into the soil for the full depth of treatment. Mix the lime into the soil to provide a minimum compacted depth of 8". A minimum number of mixing passes will be required to ensure uniform incorporation of the lime. Add water as necessary and thoroughly mix with the soil lime mixture so that the mixture contains no less than optimum moisture. A tolerance of 3% above optimum will be allowed. Incorporate all of the lime thoroughly and uniformly into the soil layer to the full depth of treatment in such a manner that the result is a homogeneous, friable mixture of soil and lime, free of clods or lumps exceeding 2" in size.

After primary mixing operations and prior to curing, shape and lightly compact the lime-treated area to the approximate section to allow for proper drainage and to minimize evaporation loss.

(B) Preliminary Curing

Following primary mixing operations, cure the stabilized layer for 1 to 4 days. The actual duration of this curing period will be determined by the Engineer. During the curing period keep the surface of the material moist to prevent drying and cracking, and maintain in a properly sealed and crowned condition. Mix, compact, shape, and finish the stabilized layer no later than 4 days after primary mixing.

(C) Final Mixing and Pulverizing

Immediately after the completion of the preliminary curing period, Mix and pulverize completely the stabilized layer to the full depth of the stabilization. Continue the final mixing until all of the clods are broken down to pass a 1/2" sieve and at least 80% pass a No. 4 sieve, exclusive of rock. Add water as required during the final mixing to raise the moisture content prior to compaction.

501-10 COMPACTING, SHAPING, AND FINISHING

Begin compaction of the mixture immediately after completion of the final mixing operations. Aerate or moisten the mixture as necessary during compaction operations to maintain the moisture between optimum and optimum plus 2%. Compact the full depth of the mixture to a density equal to at least 97% of that obtained by compacting a sample of the soil lime mixture in accordance with AASHTO T99 as modified by the Department. Copies of these modified procedures are available upon request from Materials and Tests Unit. Accompany the compaction with sufficient blading to eliminate irregularities.

Perform the final rolling of the completed surface with a pneumatic- tired roller or if permitted a smooth, steel wheel roller.

Complete shaping, final mixing, compacting and finishing on the same day upon completion of the preliminary curing. This work is to be completed no later than 4 days after primary mixing and done during daylight hours, unless otherwise provided in the contract. If the above work is not completed as specified, rip up the entire section and add additional lime, as directed, at no additional cost to the Department.

501-11 THICKNESS

The compacted thickness of the completed treated soil layer will be determined by measurements made in test holes located at random intervals not to exceed 500 feet. Do not deviate the measured thickness from that shown on the plans by more than plus 1" or minus 1/2".

Where the lime-treated soil layer is deficient in thickness by more than 1/2", remove and replace the area of deficient thickness with lime-treated soil having the required thickness at no cost to the Department.

As an exception to the above, if the deficiency is not considered sufficient to seriously impair the required strength of the lime-treated soil layer, the deficient area may, at the discretion of the Engineer, be left in place. However, only 50% payment will be made for the lime-treated soil and the theoretical amount of lime used.

501-12 FINAL CURING

After the lime-treated soil has been finished in accordance with Article 501-10, protect it against drying for a 7-day curing period in accordance with the requirements of Section 543.

501-13 TRAFFIC

Completed sections of the lime-treated soil may be opened when necessary to lightweight local traffic, provided it has hardened sufficiently to prevent marring or distorting of the surface, and provided the curing is not impaired. Do not use construction equipment on the lime-treated soil except as necessary to discharge material into the spreader during paving operations, or except as may be otherwise permitted for embankment construction.

501-14 MAINTENANCE

Maintain the lime-treated soil in an acceptable condition until final acceptance of the project. Include immediate repair of any defects or damage that may occur in maintenance operations. Perform this work at no cost to the Department and repeat as often as may be necessary to keep the lime-treated soil in an acceptable condition. Perform repairs to lime-treated soil by replacing the lime-treated soil for its full depth rather than by adding a thin layer of lime stabilized material to the existing layer. An alternate repair method may be used if approved in writing.

501-15 MEASUREMENT AND PAYMENT

Lime-treated soil will be measured and paid for as the number of square yards of each layer of lime-treated soil that has been completed and accepted. In determining this quantity, the width of the lime-treated soil will be measured across the top surface of the treated layer. The length will be the actual length constructed, measured along the centerline of the surface of the treated layer.

Lime for Lime-Treated Soil Where hydrated lime or quick lime is spread directly on the soil in solid form or when hydrated lime is used to produce a slurry, the quantity of lime to be paid for will be the number of tons of lime that has been incorporated into the soil at the required rates. No measurement will be made of any lime added or replaced for corrective measures during construction or for repairing damaged areas. Measurement is to be made in bulk in the truck on certified platform scales or other certified weighting devices.

Where quicklime is slaked on the project and applied in slurry form, measurement will be calculated as indicated below for each truckload using the certified lime purity for that load.

A = Certified weight of quicklime delivered x % purity x 1.32
B = Certified weight of quicklime delivered x % inert material
A+B = Total hydrated lime produced (pay quantity)

The quantity of lime, measured as provided in Subarticle 501-15(B), will be paid for at the contract unit price per ton for "Lime for Lime-Treated Soil".

Asphalt curing seal will be paid for as provided in Article 543-5.

Blotting sand will be paid for as provided in Article 818-5.

In the event that a layer of lime-treated soil is deficient in thickness but has been permitted to be left in place in accordance with Article 501-11, payment for that lime treated soil and lime will be made at 50 percent of the contract unit prices for Lime-Treated Soil and Lime for Lime-Treated Soil.

Payment will be made under:

Pay Item	Pay Unit
Lime-Treated Soil	Square Yard
Lime for Lime-Treated Soil	Ton

SECTION 510
AGGREGATE STABILIZATION

510-1 DESCRIPTION

Perform the work covered by this section including but not limited to furnishing all aggregate and water; hauling, spreading, and mixing the required amount of aggregate with the subgrade materials; shaping and compacting the stabilized subgrade to the required grade and typical section; and maintaining the aggregate.

510-2 MATERIALS

Refer to Division 10

Item	Section
Stabilizer aggregate	1008-1

510-3 CONSTRUCTION METHODS

(A) Mixing

Remove sufficient subgrade material, if necessary, to compensate for the addition of the stabilizer aggregate. Spread the quantity of aggregate required by the contract uniformly over the subgrade by means of a mechanical spreader. Spread the aggregate on the subgrade in advance of the mixing operations only to the extent that processing can be completed within one week. Mix the aggregate with the top 3" of the subgrade soil. Continue mixing until the aggregate is uniformly mixed with the soil to the width and depth to be treated.

Have the aggregate sampled, tested, and approved prior to the placing layers of base material or pavement thereon.

(B) Shaping and Compaction

Shape the stabilized subgrade to the lines, grades, and typical sections shown on the plans.

Compact the entire depth and width of the stabilized subgrade to a density equal to at least 100% of that obtained by compacting a sample of the material in accordance with AASHTO T99 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit. Compact

the stabilized subgrade at a moisture content which is approximately that required to produce the maximum density indicated by the above test method. Dry or add moisture to the material as required to provide a uniformly compacted and acceptable subgrade.

510-4 TOLERANCE

A tolerance of plus or minus 1/2" from the established grade will be permitted after the stabilized subgrade has been graded to a uniform surface.

Perform grading of the subgrade such that the maximum differential between the established grade and the stabilized subgrade within any 100 foot distance is 1/2".

510-5 PROTECTION

The requirements of Article 500-4 will be applicable to the protection of the aggregate stabilized subgrade.

510-6 MEASUREMENT AND PAYMENT

Stabilizer aggregate will be measured and paid as the actual number of tons of aggregate, exclusive of any corrective material, which has been mixed with the completed and accepted subgrade. This quantity will be measured as provided for in Article 520-11.

Payment will be made under

Pay Item	Pay Unit
Stabilizer Aggregate	Ton

SECTION 520
AGGREGATE BASE COURSE

520-1 DESCRIPTION

Perform the work covered by this section including but not limited to constructing a base composed of an approved aggregate material hauled to the road, placed on the road, mixed, compacted, and shaped to conform to the lines, grades, depths, and typical sections shown in the plans and applying a sand seal in accordance with the requirements of Article 520-5, and maintaining the base.

520-2 MATERIALS

Refer to Division 10

Item	Section
Aggregate base course	1006 and 1010

520-3 METHODS OF PRODUCTION

Furnish aggregate upon which no restrictions are placed on the production or stockpiling except as provided in Sections 1005, 1006, and 1010. Place on the roadway aggregates which have been sampled, tested and approved in accordance with the requirements of Article 520-6.

520-4 SUBGRADE PREPARATION

Prepare the subgrade in accordance with Section 500 prior to placement of the base material.

520-5 HAULING AND PLACING AGGREGATE BASE MATERIAL

Place the aggregate material on the subgrade with a mechanical spreader capable of placing the material to a uniform loose depth and without segregation except that for areas inaccessible to a mechanical spreader, the aggregate material may be placed by other methods approved by the Engineer.

Where the Contractor elects to use more than one source of aggregate as described in Section 1005, place the various types of aggregate used in an approved manner which will permit the sampling and testing required by Section 1006 and 1010.

Where the required compacted thickness of base is 10" or less, the base material may be spread and compacted in one layer. Where the required compacted thickness is more than 10" spread the base material and compact in 2 or more approximately equal layers. Compact the base material to a minimum thickness of approximately 4" for any one layer.

Have each layer of material sampled, tested, compacted, and approved prior to placing succeeding layers of base material or pavement.

Do not place base material on frozen subgrade or base.

Cover, within 7 calendar days, base course placed between November 15 and March 15 inclusive with a subsequent layer of pavement structure or with a sand seal. Apply sand seal in accordance with the requirements of Section 660 except that Articles 660-3 and 660-11 will not apply.

Failure by the Contractor to cover the base course as required above will result in the Engineer notifying the Contractor in writing to cover the base course with a sand seal and to suspend the operations of placing aggregate base course until such cover has been placed. Perform this work at no cost to the Department. In the event that the Contractor fails to apply the sand seal within 72 hours after receipt of such notice, the Engineer may proceed to have such work performed with other forces and equipment. The cost of such work performed by the Department will be deducted from monies due or to become due the Contractor. The application of the sand seal by the Contractor or by others will in no way relieve the Contractor of the responsibility to maintain or repair the damaged base or subgrade, no matter what the cause of damage, at no cost to the Department.

Do not allow traffic on the completed base course other than necessary local traffic and that developing from the operation of essential construction equipment as may be authorized by the Engineer. Repair any defects that develop in the completed base or any damage caused by local or construction traffic acceptably at no cost to the Department. Hauling equipment may be operated with the approval of the Engineer, over a lower layer of base, however, acceptably repair any rutting, weaving, or soft areas that develop at no cost to the Department.

Do not exceed 35 miles per hour with hauling equipment traveling over any part of the base.

Utilize methods of handling, hauling, and placing which will minimize segregation and contamination. If segregation occurs, the Engineer may require that changes be made in the Contractor's methods to minimize segregation, and may also require mixing on the road which may be necessary to correct any segregation. No additional compensation will be allowed for the work of road mixing as may be required under this provision. Remove and replace all aggregate which is contaminated with foreign materials to the extent that the base course will not adequately serve its intended use at no additional cost to the Department. The above requirements will be applicable regardless of the type of aggregate placed and regardless of prior acceptance.

520-6 SAMPLING, TESTING, AND ACCEPTANCE

Perform sampling for the determination of gradation, liquid limit, and plasticity index for the various types of aggregate, as defined in Articles 1010-1, and 1010-2.

Where visual observation indicates the need to do so, the Engineer may require the Contractor to road mix areas of nonuniform gradation at no additional cost to the Department. The Engineer reserves the right to take samples in addition to the lot acceptance samples from within the lot in areas exhibiting nonuniform gradation. When the test results from such an additional sample is outside the gradation limits given in Column C of Table 1010-1 and the nonuniformity cannot be corrected by road mixing, the aggregate base course represented by the sample will be rejected and replaced by the Contractor at no cost to the Department.

520-7 SHAPING AND COMPACTION

Machine and compact the layer of base within 48 hours after beginning the placing of a layer of the base. Maintain each layer to the required cross section during compaction and compact each layer to the required density prior to placing the next layer.

When electing to use conventional density test number 3 (ring test) to determine density, compact each layer of the base to a density equal to at least 100% of that obtained by compacting a sample of the material in accordance with AASHTO T180 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit.

Follow the requirements as specified in Article 520-9 when electing to use nuclear methods to determine the density.

Compact the base material at a moisture content which is approximately that required to produce a maximum density indicated by the above test method. Dry or add moisture to the material when required to provide a uniformly compacted and acceptable base.

Shape the final layer of base material to conform to the lines, grades, and typical section as shown on the plans. Construct the base course so that it is smooth, hard, dense, unyielding, and well bonded upon completion. A broom drag may be used in connection with the final finishing and conditioning of the surface of the base course.

520-8 TOLERANCES

After final shaping and compacting of the base, the Engineer will check the surface of the base for conformance to the grade and typical section and determine the base thickness.

Construct the base so that the thickness of the base is within a tolerance of plus or minus 1/2" of the base thickness required by the plans.

Construct the base so that the maximum differential between the established grade and the base within any 100-foot section is 1/2".

520-9 DENSITY DETERMINATION BY NUCLEAR METHODS

(A) Application

The Engineer may utilize nuclear means as described below to determine the density of selected base course materials required by Sections 520 and 540. The target density will be from the material's most recent AASHTO T180 test results, which may be obtained from the Materials and Tests Unit.

A new target density is to be obtained when there is a change in the source of material, when a significant change occurs in the composition of the materials from the same source, or when determined necessary.

Testing will be performed in the direct transmission mode on all aggregate base course. Additional information on testing is provided in the current N.C.D.O.T. Nuclear Gauge Operator's Manual, copies of which are available from the Materials and Tests Unit.

(B) Test Sections

(1) General

Provide a test section which has a depth no greater than the layer depth shown in the plans or required by the Specifications, whichever is less. Determine the length of the section by the width as shown in the current *Nuclear Gauge Operator's Manual*.

In situations where the chemical composition of the material affects the gauge moisture readings, the Materials and Tests Unit will provide specific instructions.

(2) Equipment

Equipment used in the compaction of test sections shall be approved prior to use. Where uniform density is not being obtained throughout the depth of the layer of material being tested, change the type and/or weight of the compaction equipment as necessary to achieve uniform density even though such equipment has been previously approved.

When aggregate base course material is involved, use at least one steel wheel vibratory roller weighing not less than 6 tons.

(3) Compaction

After the material in a test section has been spread and shaped to the required width and depth, begin the compaction of the section. Carry out compaction in such a manner as to obtain uniform maximum density over the entire test section.

Immediately prior to compacting the aggregate base course material, make sure it has satisfactory moisture content. If it is necessary to add water after the material is placed, scarify the material, and add water uniformly throughout the full depth of the layer of the base course material.

(4) Testing Procedures

After the Contractor has completed compaction of the test section, the Engineer will conduct 5 density tests at random within 5 equal segments of the test section. Provide a smooth surface on the material being tested prior to any tests being performed. Density tests will not be made when the surface of an aggregate base course contains free moisture. The required density will be expressed as a percentage of the target density.

(5) Acceptance Requirements

Provide a density for aggregate base course of at least 98% of the nuclear target density. In addition, the nuclear density of any single test location shall be at least 95% of the nuclear target density.

The required density will be determined by the average of 5 nuclear density tests made at random locations within 5 equal segments of the test sections.

520-10 MAINTENANCE

Where the base material is placed in a trench section, provide adequate drainage through the shoulders to protect the subgrade and base until such time as the shoulders are completed.

Maintain the surface of the base by watering, machining, rolling, or dragging when necessary to prevent damage to the base by weather or traffic.

Where the base or subgrade is damaged, repair the damaged area; reshape the base to required lines, grades, and typical sections; and recompact the base to the required density at no cost to the Department.

520-11 MEASUREMENT AND PAYMENT

Aggregate Base Course will be measured and paid for at the contract unit price per ton for will be the actual number of tons of aggregate which has been incorporated into the completed and accepted work.

When the Contractor has elected to leave a lot in place which exceeds the range of Column D of Table 1010-1, but which is otherwise in accordance with the requirements of Article 1010-2, the quantity of base course included in this lot will be paid for at a reduced unit price. The reduced unit price will be established in accordance with Article 1010-2.

The aggregate will be measured by being weighed in trucks on certified platform scales or other certified weighing devices. If permitted by the contract, the weight of base course material shipped by barge may be determined from water displacement measurements.

No deductions will be made for any moisture contained in the aggregate at the time of weighing.

Payment will be made under

Pay Item	Pay Unit
Aggregate Base Course	Ton

SECTION 530
SOIL TYPE BASE COURSE

530-1 DESCRIPTION

Perform the work covered by this section including but not limited to furnishing the source of material; building, maintaining, and obliterating haul roads; clearing and grubbing the material source; removal and disposal of overburden; excavation; hauling; spreading materials; mixing; compacting; shaping to conform to the lines, grades, depth, and typical sections shown on the plans; reconditioning; maintaining the base; restoration of the source and haul roads to an acceptable condition; and seeding and mulching the source.

530-2 MATERIALS

Refer to Division 10

Item	Section
Soil type base course	1010-3

530-3 PREPARATION OF SUBGRADE

Prepare the subgrade in accordance with the requirements of Section 500.

530-4 MATERIAL SOURCES

(A) General

Clear and grub the surface of the material sources and thoroughly clean it of all unsuitable material before beginning excavation. Dispose of material resulting from clearing and grubbing in accordance with Article 200-5. Remove and dispose of overburden in accordance with Section 802.

Where payment is to be made by measuring the material in its original position, notify the Engineer sufficiently in advance of beginning excavation of this material in order that the area may be staked and cross sectioned by the Engineer. No payment will be allowed for any material excavated prior to cross sections being taken. Excavate the material to the lines and slopes as staked by the Engineer and perform the excavation in an orderly manner to facilitate measurement at any time.

Where payment is to be made by truck measurement, furnish trucks with bodies suitable for accurate measurement. Load trucks uniformly and in such a manner as to prevent spillage.

Where it is necessary to haul material over existing roads or streets, the requirements of Article 105-15 will apply. Use all necessary precautions to prevent damage to the existing structures or pavement. Conduct hauling operations in such a manner as to not interfere with the normal flow of traffic and keep the traffic lanes free from spillage at all times.

(B) Department Furnished Sources:

Where the Department furnishes material sources, the location of such sources will be as designated on the plans.

The Department will furnish the necessary haul road right of way at locations designated by the Engineer. Build, maintain, and when directed, obliterate all haul roads required at no cost to the Department. Where the haul road is to be reclaimed for cultivation, plow or scarify the area to a minimum depth of 8 inches.

Remove overburden prior to the excavation of the base material when indicated by the plans.

Where it is necessary to drain the material source, perform this work in accordance with Section 240.

Leave the material source in a neat and presentable condition after use. Smooth, round, and construct all slopes not steeper than 2:1. Plow or scarify to a minimum depth of 8 inches, disc harrow, and construct terraces where the source is to be reclaimed for cultivation.

Seed and mulch the sources in accordance with Sections 1620, 1660, 1661, or 1663.

(C) Contractor Furnished Sources

Approval of material sources furnished by the Contractor is subject to the requirements of Subarticle 230-4(C).

(D) Substitute Sources

Follow the requirements of Subarticle 530-4(C) when electing to substitute material sources for those provided by the Department.

530-5 PLACING MATERIAL

Deposit the material on the subgrade in such a manner that when all layers are spread, mixed, and compacted, the required depth of base material will be obtained. Where more than one type of material is to be used, spread each uniformly over the subgrade prior to placing the next material.

530-6 MIXING AND COMPACTING

Immediately after placing and spreading the base material, begin mixing operations. Perform the mixing in a manner which will produce a thoroughly and uniformly mixed base course.

Compact the base uniformly throughout the depth and width of the base. Where the base is thicker than 8", spread the base and compact it in 2 layers approximately equal in thickness.

Compact the base to a density equal to at least 100% of that obtained by compacting a sample of the material in accordance with AASHTO T99 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit.

Compact the base material at a moisture content which is approximately that required to produce the maximum density indicated by the above method. Dry or add moisture to the material when required to provide a uniformly compacted and acceptable base.

530-7 FINAL SHAPING

Shape the base to conform to the lines, grades, and typical sections shown on the plans. Take care to prevent the formation of slippage planes in the surface. Thoroughly dry, remix or remove and replace all soft or unstable areas.

530-8 SAMPLING, TESTING, AND ACCEPTANCE

Where the depth of the base is such that the placement of more than 1 layer is required for proper mixing and compacting, sample, test and have approved each layer of material prior to placing additional base material thereon.

Samples will be taken from the road immediately after the base material has been spread, mixed, and shaped to a true cross section. Sampling and testing for acceptance will be as hereinafter provided.

Use a sampling unit consisting of 500 linear feet when the roadway base is placed in widths 27 feet or less. Use a sampling unit consisting of 1,000 square yards when the base is placed in widths over 27 feet. As an exception to the above, when the base course is constructed utilizing materials in the existing subgrade the sampling units will be reduced to one half the size indicated above. Use a sampling unit consisting of 1,000 linear feet when placing base on a shoulder or widening of 12 feet or less.

One sample will be taken from a location selected by the Engineer in each unit. The sample will be taken by cutting 3 cores for the full depth of the base course, one on the center line and one approximately 3 feet from each edge, and combining the material as one sample representing the material in that unit.

If the sample tested fails to meet specification requirements, obtain 2 check samples, one on each side of the original sample at 50 feet spacing. The unit will be rejected unless both of these samples meet specification requirements.

Where a unit is rejected, no further samples will be taken from that unit until the material is either corrected by the addition and mixing of suitable material or the rejected material is removed and replaced.

Where the material source is furnished by the Contractor and the Engineer permits the Contractor to correct a rejected unit by the addition and mixing of corrective material, perform all work necessary due to the addition of the corrective material at no cost to the Department.

Where the material source is furnished by the Contractor and the rejected unit is in a final layer of base, furnish and incorporate any material added to correct gradation at no cost to the Department.

Resampling of a corrected or replaced unit will be performed in the same manner as original sampling.

530-9 TOLERANCES

After final shaping and compacting of the base, the Engineer will check the surface of the base for conformance with the grade and typical section and will determine the base thickness.

Construct the base with a thickness that is within a tolerance of plus or minus 1/2" of the base thickness required by the plans.

Construct the base such that the maximum differential between the established grade and the base within any 100-foot section is 1/2".

530-10 RECONDITIONING

Where sampling and testing indicate that additional material shall be added to the base to produce the required quality, add the required material, remix, recompact, and reshape the base to the required lines, grades, and typical sections.

Where the Contractor furnishes the material source, perform the work of reconditioning at no cost to the Department.

530-11 MAINTENANCE

Where the base material is placed in a trench section, provide adequate drainage through the shoulders to protect the subgrade and base until such time as shoulders are completed.

Maintain the surface of the base by machining, watering, and rolling or dragging when necessary to prevent damage to the base by weather or traffic.

Within 24 hours of completion of the base, prime the base slopes where required or, where prime is not required, place sufficient shoulder material against the edges of the completed base to protect the base.

Where the base or subgrade is damaged due to negligence on the part of the Contractor, repair the damaged area; reshape the base to the required lines, grades, and typical sections; and recompact the base to the required density at no cost to the Department.

530-12 MEASUREMENT AND PAYMENT

Soil Type Base Course, Type _____ will be measured and paid for at the contract unit price per cubic yard or ton for the actual number of cubic yards or tons of base course material that has been incorporated into the completed and accepted work. However, no measurement will be made of any additional material which the Engineer has permitted the Contractor to incorporate into a final base layer in the work of reconditioning where the Contractor has furnished the material source.

Measurement of the base course material will be made in accordance with one of the following methods:

1. When the material is to be measured in its original position, measurement will be made by cross sections and computations will be made by the average end area method. No measurement will be made of any material excavated prior to cross sections being taken.

2. When the material is to be measured in trucks, the level to which each truck is to be loaded will be measured by the Engineer and each truck shall be suitably marked to indicate the loaded level. Each truck shall bear a suitable mark or number for identification. Load each truck to at least its measured load level when it arrives at the point of delivery. The recorded quantity of material will be adjusted by making a 25 percent deduction to allow for shrinkage, and the adjusted quantity will be the quantity to be paid for.
3. Where the contract calls for the material to be paid for by the ton, the material will be measured by being weighed in trucks on certified platform scales or other certified weighing devices. No deduction will be made for any moisture contained in the material at the time of weighing.

(A) Reconditioning Road

When material sources are furnished by the Department and the Engineer directs the incorporation of additional material into a rejected sampling unit, the work of reconditioning as provided in Article 530-10 will be measured as provided below.

When the Contractor furnishes material sources, no measurement of reconditioning will be made.

The quantity of reconditioning to be paid for at the contract unit price per 1,000 square yards for *Reconditioning, Soil Type Base Course*. will be the actual number of units of 1,000 square yards of base course over which the work of reconditioning has been acceptably performed. The length will be the actual length measured along the centerline of the surface of the base. The width will be the width required by the plans or as directed by the Engineer measured across the top surface of the base.

Where the material source has been furnished by the Department, payment for clearing and grubbing the source will be made as provided in Article 200-7, payment for removal and disposal of overburden will be made as provided for unclassified excavation in Article 225-7, payment for draining the source will be made as provided in Article 240-4, and payment for seeding and mulching the source when required will be made as provided in Article 1660-8.

Where the material source has been furnished by the Contractor, no separate payment will be made for clearing or grubbing, removal and disposal of overburden, draining the source, or seeding the mulching as such work will be considered as incidental to the work covered by this section.

Payment will be made under

Pay Item	**Pay Unit**
Soil Type Base Course, Type _____	Cubic Yard
Soil Type Base Course, Type _____	Ton
Reconditioning, Soil Type Base Course	1,000 Square Yards

SECTION 535
CONDITIONING EXISTING BASE

535-1 DESCRIPTION

Perform the work covered by this section including but not limited to scarifying, shaping, furnishing water, compacting, and maintaining the base. Included in the work is:

1. Conditioning of an existing base to prepare it for the placement of a pavement directly upon the base. Included in the conditioning is scarifying, shaping, and compacting the base to conform to the required lines, grades, depths, and typical sections established by the plans.
2. Conditioning of an existing base in preparation for the placement of additional layers of base material. Included in the conditioning is scarifying, shaping, and compacting the base to conform to the approximate lines, grades, depths, and typical sections established by the plans.

535-2 CONSTRUCTION REQUIREMENTS

Compact the base to a degree satisfactory to the Engineer. Dry or add moisture to the material when required to provide a uniformly compacted and acceptable base.

Do not condition the existing base when it contains excess moisture or is frozen.

Maintain the base in accordance with the requirements of Article 520-10 or 530-11.

535-3 MEASUREMENT AND PAYMENT

Conditioning existing base will be measured and paid for at the contract unit price per 1,000 square yards for the actual number of units of 1,000 square yards of base over which the work of conditioning existing base has been acceptably performed. The length will be measured along the centerline of the surface of the base. The width will be the width required by the plans or established by the Engineer measured across the top surface of the base.

Payment will be made under

Pay Item	Pay Unit
Conditioning Existing Base	1,000 Square Yards

SECTION 540
CEMENT TREATED
BASE COURSE

540-1 DESCRIPTION

Perform the work covered by this section including but not limited to construction and curing a cement treated base composed of aggregate, furnishing of water and aggregate; the mixing, proportioning, hauling, and spreading of the materials; furnishing Portland cement at the point where it is incorporated into the mix; manipulating, compacting, and finishing the base; maintaining the base; making repairs or corrections to the base; and applying sand

seal in accordance with Article 540-3. Compact, shape, and cure the base to conform to the lines, grades, depths, and typical sections shown on the plans.

When Cement Treated Base Course is called for on the plans, the Contractor has the option of providing a Plant Mixed Cement Treated Base Course or a Road Mixed Cement Treated Base Course as specified below.

540-2 MATERIALS

Refer to Division 10

Item	Section
Aggregate	1010-4
Portland Cement, Type I	1024-1
Water	1024-4

Use aggregate that meets the requirements of Article 1010-1 and Article 1010-2 or Article 1010-3, except for gradation which meets the requirements of Table 1010-4.

540-3 LIMITATIONS

Do not construct cement treated base from November 1 to March 15 inclusive. Do not construct base when the air temperature is less than 40°F in the shade nor when conditions indicate that the temperature may fall below 40°F within 24 hours. Do not incorporate frozen materials into the mixture nor place material on frozen subgrade. Protect the base from freezing for a period of 7 days after completion. Perform work during daylight hours unless otherwise provided by the requirements of the traffic control plans.

Do not place cement treated base that will not be covered with pavement by December 1st of the same year. Failure of the Contractor to cover the cement treated base as required above will result in the Engineer notifying the Contractor in writing to cover the cement treated base with a sand seal. Apply the sand seal in accordance with the requirements of Section 660 except that Articles 660-3 and 660-11 will not apply. Perform this work at no cost to the Department. In the event the Contractor fails to apply the sand seal within 72 hours after receipt of such notice, the Engineer may proceed to have the work performed with other forces and equipment. The cost of such work performed by other forces will be deducted from monies due or to become due the Contractor. The application of the sand seal by the Contractor or other forces will in no way relieve the Contractor of the responsibility to maintain or repair the damaged base, no matter what the cause of damage, at no cost to the Department.

540-4 PREPARATION OF SUBGRADE

Prepare the subgrade in accordance with Section 500. Prepare the subgrade so that it is firm and able to support without displacement the construction equipment and the compaction operations hereinafter specified. Soft or yielding subgrade will be corrected and made stable before construction proceeds. Moisten the subgrade as needed prior to spreading the base material.

540-5 CONSTRUCTION METHODS

(A) General

Composition of Mixture

When the Contractor proposes to use a source of aggregate that is not documented by a currently approved job mix formula, submit to the Department's Materials and Tests Unit, samples of all aggregates proposed for use at least 3 weeks prior to beginning production. Take the aggregate samples in the presence of the Engineer. Submit in writing the proposed gradation for the cement treated base material. The Department will then prepare a mix design based upon the samples submitted and the Contractor's stated proposed gradation.

A job mix formula will be established for the cement treated base material within the design limits indicated in Table 1010-4, Column B. Use the job mix formula unless modified in writing by the Engineer.

Prepare all cement-treated base material mixtures so that they conform to the job mix formula within the tolerance ranges specified in Table 540-1. In the event the Contractor is not able to maintain the production within the tolerance ranges specified in Table 540-1, production will cease until such time as a new mix design and job mix formula has been established and approved by the Engineer.

TABLE 540-1
TOLERANCES FOR JOB MIX FORMULA
PORTLAND CEMENT-TREATED BASE

Sieve Size	Tolerance for Percent Passing
1 1/2"	0
1"	± 5
1/2"	± 8
No. 4	± 7
No. 10	± 7
No. 40	± 4
No. 200	± 2
Material Passing No. 10 Sieve (Soil Mortar)	
No. 40	± 8
No. 200	± 5

(B) Plant Mixed Cement-Treated Base Course

(1) Mixing

(a) General

Add to the aggregate the quantity of cement specified by the Engineer.

Thoroughly mix the cement, aggregates, and water in an approved central mixing plant. Use a batch or continuous-flow type stationary

mixer and equip it with feeding and metering devices that will add aggregate, cement, and water into the mixer in the specified quantity. Use batch weights or rates of feed of cement that are within 0.3 percent of the quantity designated by the Engineer. Use batch weights or rates of flow of water that are within a range of optimum to optimum plus 1.5 percent moisture. Use batch weights or rates of feed of aggregate that are within 5 percent of the amounts designated by the Engineer.

Mix materials a minimum of 20 seconds to assure a proper blend of materials.

(b) Batch Type Plant

Equip the mixer with a sufficient number of paddles of a type and arrangement to produce a uniformly mixed batch.

Add water during the mixing operation as required to provide the quantity of moisture specified; however, do not add water to the mixture before the aggregate and cement have been mixed sufficiently to prevent the formation of cement balls.

Equip the mixer with a timing device which will indicate by a definite audible or visual signal the expiration of the mixing period.

(c) Continuous Flow Type Plant

Calibrate and mark cement storage silos so that the amount of cement in the silo can be readily determined at any time. Design feeders and/or meters for introducing the cement into the mixer such that the amount of cement can be accurately determined before it is introduced into the mixer. Use a variable speed motor on the cement feeder which is regulated by a control mechanism indicating the speed of the motor in r.p.m. or equivalent measure. Design the indicator so that it can be read in daylight from a point 4 feet from the indicator. Equip the cement holding tank which is used in feeding cement with an air pressure gauge and air pressure regulating control such that air pressure can be regulated to a uniform flow.

Measure the water by a meter which determines flow in gallons per minute and control it with 2 valves. Use a variable flow valve for controlling the rate of flow of the water only on one valve and use an on-off valve connected to the plant controls such that the water is turned on and/or off when the plant is started and stopped for the other valve.

After the material has been processed by the pug mill, store it in a holding bin with the minimum capacity of 3 tons before discharging into trucks. Hold the material in the holding bin for loading purposes only and do not store for loading subsequent trucks. Loading trucks directly from a belt or auger box will not be permitted.

Have available a satisfactory platform for obtaining samples from trucks. Make provisions for calibrating the plant daily and at other

times as deemed necessary by the Engineer. On plants that are electronically controlled, manual calibration will be required to verify the electronic calibration and shall be performed at the beginning of a project. If the plant operation is interrupted by more than 4 calendar days during an active project, perform the manual calibration process again. Perform random manual calibrations at the direction of the Engineer.

(2) Hauling and Placing

Haul the mixed base material to the roadway in trucks with protective covers to avoid moisture loss. Do not exceed 1 hour between the loading of the haul trucks and the beginning of compaction.

Place stringlines for alignment control for placing a layer of base.

Place the base in a uniform layer on the moistened, prepared subgrade to produce the depth required by the plans. To insure homogenous distribution of the base material in each layer, place the material using approved spreaders. Perform the spreading operations in such a manner as to eliminate pockets of material of non-uniform gradation resulting from segregation in the hauling or discharging operations. Spread each layer so that compaction can be started without further shaping.

A single spreader may be used provided it is capable of placing a uniform, full-depth layer of material across the full width of the base in one pass. Otherwise, 2 or more spreaders will be required, and operate the spreaders so that the spreading progresses along the full width of the base in a uniform manner.

Base placed on areas inaccessible to mechanical spreading equipment may be spread in one layer by approved methods. After spreading, compact the material thoroughly to the required lines, grades, typical sections by means of pneumatic tampers, or with other compaction equipment which will constantly obtain the degree of compaction required.

(C) Road Mixed Cement-Treated Base Course

(1) Equipment

Use any combination of machines or equipment that will produce the required results meeting the approval of the Engineer. Use a cement spreader which has an adjustable rate of flow and the capability of spreading the required amount of cement in one pass. Mix cement, aggregate, and water with a self-propelled rotary mixer capable of mixing to a depth of 10". Correct any leakage of fluids and/or materials promptly or the Engineer may order such equipment removed and replaced with satisfactory equipment. Use equipment and methods for applying cement, water, curing seal, and blotting sand that does not damage the base and meets the requirements of Article 107-22.

(2) Spreading and Mixing

Place the required quantity of aggregate on the prepared subgrade in a uniform layer. Spread aggregate on the subgrade in advance of the mixing operations only to the extent that processing can be completed within one week. Apply the required quantity of cement in a uniform spread on the aggregate in place and immediately blend the aggregate until the cement is uniformly distributed throughout the aggregate. Have the moisture content at or below the optimum moisture at the time of application of the cement. Do not apply cement on excessively windy days and apply only to such an area that all operations shall be completed on the same day during daylight hours.

The Engineer will establish the actual cement content during construction.

Immediately after the aggregate and cement have been thoroughly blended, apply water as needed and incorporate into the mixture. Control the application of the water so that there is no excessive concentration on or near the surface of the mixture. After the necessary water has been applied, continue mixing until a thorough and uniform mixture is obtained.

Maintain the moisture content at the time of final mixing and during compaction within a range of optimum to optimum plus 1.5% as determined. Make sure that the moisture content in the mix does not exceed the quantity that will cause the base course to become unstable during compaction or finishing operations.

540-6 COMPACTION

Begin compaction immediately after the plant mixed base has been placed on the prepared subgrade or immediately after cement and water has been incorporated into the previously placed aggregate. Compact any one layer of base so that the thickness does not exceed 8" and is not be less than 4".

After spreading, maintain the moisture content of the material within a range of optimum to optimum plus 1.5% moisture during compaction. Accomplish compaction by the use of approved self-propelled rollers except do not use a sheep-foot roller for more than 2 passes. Compact the base by the use of approved self-propelled rollers to a density equal to at least 97% of the maximum density obtained by compacting a sample of the material in accordance with AASHTO T180 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit. The Engineer may, at his option, utilize nuclear methods as described in the current Nuclear Gauge Operators Manual to determine the density of the base in lieu of the methods required above. Copies of this manual are available upon request from the Materials and Tests Unit.

Complete final compaction, including that necessary due to correction of high or low areas, within 3 hours after water has been added to the mixture. Do not leave any cement-aggregate mixture undisturbed for more than 30 minutes if it has not been compacted and finished. When rain causes excessive moisture, reconstruct the entire section. When such reconstruction is necessary, perform the work of reconstruction and provide the cement required at no cost to the Department.

540-7 CONSTRUCTION JOINTS

At the end of each day's construction, form a straight transverse construction joint by cutting back into the completed work to form a vertical face. Build the base for large, wide areas in a series of parallel lines of convenient length and width meeting the approval of the Engineer. Form straight longitudinal joints at the edge of each day's construction by cutting back into the completed work to form a vertical face free of loose or shattered materials. Where traffic considerations require that a longitudinal joint be exposed for an excessive length of time, the Engineer may require that it be covered with a curing seal in accordance with Section 543.

540-8 TOLERANCES

After final shaping and compacting of the base, the Engineer will check the surface of the base for conformance to the grade and typical section and determine the base thickness.

Construct the thickness of the base so that it is within a tolerance of plus or minus 1/2" of the base thickness required by the plans.

Construct the base so that the maximum differential between the established grade and the base within any 100-foot section is 1/2".

540-9 CURING

After the cement treated base has been finished as specified herein, cure it in accordance with Section 543.

540-10 AGGREGATE FOR CEMENT-TREATED BASE

Use aggregate for cement-treated base course from an approved source participating in the Department’s Aggregate Quality Control/Quality Assurance Program (Aggregate QC/QA Program) which has been sampled, tested, and approved in accordance with the requirements of Article 1010-4.

540-11 TRAFFIC

Completed sections of the base may be opened when necessary to lightweight local traffic, provided the base has hardened sufficiently to prevent marring or distorting of the surface, and provided the curing is not impaired. Do not operate construction equipment on the base except as necessary to discharge into the spreader during paving operations.

540-12 MAINTENANCE

Maintain the base in an acceptable condition until final acceptance of the project. Include immediate repair of any defects or damage that may occur in any maintenance operation. Perform this maintenance at no cost to the Department and repeat as often as may be necessary to keep the base in an acceptable condition. Perform repairs to the base by replacing the base for its full depth rather than by adding a thin layer of cement-stabilized material to the existing layer of base.

540-13 MEASUREMENT AND PAYMENT

Aggregate for Cement Treated Base Course will be measured and paid for at the contract unit price per ton that has been incorporated into the completed and accepted work. The quantity will be measured by weighing in trucks on certified platform scales or other

certified weighing devices. No deduction will be made for any moisture contained in the aggregate at the time of weighing. Measurement will not be made of any base mixture added or replaced for corrective measures during construction or for repairing damaged areas.

Portland Cement for Cement-Treated Base Course will be measured and paid for at the contract unit price per ton that has been incorporated into the mix. When bulk cement is used, the quantity will be measured by weighing in trucks on certified platform scales or other certified weighing devices. When cement-treated base is produced at a commercial source for more than one project, the Engineer may elect to measure the cement based upon the cement content shown in the approved job mix formula. Measurement will not be made of any cement added or replaced for corrective measures during construction or for repairing damaged areas.

Asphalt curing seal will be paid for as provided in Article 543-5.

Blotting sand will be paid for as provided in Article 818-4.

The above prices and payments will be full compensation for all work covered by this section including but not limited to the furnishing of water and aggregate; the mixing, proportioning, hauling, and spreading of the materials; furnishing Portland cement at the point where it is incorporated into the mix; manipulating, compacting, and finishing the base; maintaining the base; making repairs or corrections to the base; and applying sand seal in accordance with Article 542-3.

Payment will be made under

Pay Item	Pay Unit
Aggregate for Cement Treated Base Course	Ton
Portland Cement for Cement-Treated Base Course	Ton

SECTION 542
SOIL-CEMENT BASE

542-1 DESCRIPTION

Perform the work covered by this section including, but not limited to constructing and curing a soil cement base by treating the subgrade, existing subbase, existing base or any combination of these materials. Proportion, spread and mix the materials on the roadway; manipulate, compact and finish in accordance with these Specifications and in conformance to the lines, grades, depths and typical sections shown on the plans or established by the Engineer.

542-2 MATERIALS

Refer to Division 10

Item	Section
Portland Cement, Type I	1024-1
Water	1024-4

Use soil material that consists of material existing in the area to be paved, approved borrow material, or a combination of these materials proportioned as directed by the Engineer that is free from vegetation, roots, or other objectionable matter; and does not contain aggregate or stone larger than 2".

542-3 LIMITATIONS

Do not construct the soil-cement base from November 1 to March 15 or when the air temperature is below 40°F in the shade nor when conditions indicate that the temperature may fall below 40°F within 24 hours. Do not place or mix materials with frozen subgrade. Protect the base from freezing for a period of 7 days after completion. Perform the work only during daylight hours except as otherwise provided in the contract.

Do not construct soil-cement base that will not be covered with a layer of base or pavement by December 1st of the same year. Failure of the Contractor to cover the soil-cement base as required above will result in the Engineer notifying the Contractor in writing to cover the soil-cement base with a sand seal. Apply the sand seal in accordance with the requirements of Section 660 except that Articles 660-3 and 660-11 will not apply. Perform this work at no cost to the Department. In the event the Contractor fails to apply the sand seal within 72 hours after a receipt of such notice, the Engineer may proceed to have the work performed with other forces and equipment. The cost of such work performed by other forces will be deducted from monies due or to become due the Contractor. The application of the sand seal by the Contractor or other forces will in no way relieve the Contractor of the responsibility to maintain or repair the damaged base, no matter what the cause of damage, at no cost to the Department.

542-4 EQUIPMENT

(A) General

Use any combination of machines or equipment that will produce the required results meeting the approval of the Engineer. Correct any leakage of fluids and/or materials promptly or the Engineer may order such equipment removed and replaced with satisfactory equipment. Use equipment and methods for applying cement, water, curing seal and blotting sand that will not damage the base and meets the requirements of Article 107-22.

(B) Cement Spreaders

Use mechanical spreaders that have an adjustable rate of flow and the capability of spreading the required amount of cement in one pass.

(C) Water Distribution Equipment

Add water to the soil with a pressure distributor or other suitable equipment capable of uniformly distributing the required amount.

(D) Mixers

Perform all mixing with a self-propelled rotary mixer. Disc harrows, motor graders, and other equipment may be used only to supplement the mixing done by the rotary mixer.

Use mixing equipment that is capable of mixing to a compacted depth of at least 10".

(E) Compaction Equipment

Use self-propelled compaction equipment. Accomplish finish rolling with a pneumatic-tire roller or if permitted by the Engineer, a smooth steel-wheel roller.

(F) Scarifying Equipment

Use a grader-scarifier for the initial scarification of the soil. Use equipment capable of scarifying the soil to the full depth of the stabilized treatment. When required by the Engineer, use a weeder, spiketooth harrow, or nail drag, followed by a broom drag when scarifying during finishing operations.

542-5 PREPARATION OF ROADBED

Prior to the addition of any cement to the soil, grade and shape the area to be stabilized in close conformity to the typical sections, lines, and grades shown on the plans. Perform drying or addition of moisture where necessary prior to the application of cement. Create the subgrade so that it is firm and able to support the construction equipment and the compaction operations specified. Correct and make stable soft or yielding subgrade before construction proceeds.

542-6 SCARIFYING

Scarify the soil in the area to be stabilized to the required depth and width prior to application of cement. Pulverizing with a rotary mixer will follow scarifying except that it may be deleted in areas where, if determined, the soil types or conditions make pulverizing with a rotary mixer impractical.

542-7 APPLICATION OF CEMENT

When the Contractor has brought the subgrade to the elevation required by the plans, the Engineer will sample the soil to be stabilized in order to determine the quantity of cement to be incorporated. Incorporate 24 calendar days into the schedule to allow the Engineer sufficient time to perform the required sampling, testing, and final design of the cement stabilization.

Incorporate cement into the mix at the rate directed by the Engineer. Uniformly spread the quantity of cement required for the full depth of treatment over the surface in one pass. Do not apply cement on excessively wet grade or on windy days.

Apply cement to the soil when the percentage of moisture in the soil material is the correct amount that assures a uniform mixture of soil material and cement during the mixing operation. Do not exceed the optimum moisture content established by the Engineer for the soil-cement mixture except by permission.

The optimum moisture content and density will be determined in the field by a moisture-density test on representative samples of soil-cement mixture; however, preliminary

moisture-density values may be determined by laboratory tests using soils from the project. Moisture content will be determined by the Engineer in accordance with standard test procedures used by the Department.

Apply cement only to such an area that all operations shall be completed in the same day during daylight hours. Complete finishing the soil-cement mix within 4 hours of adding water to the soil-cement mixture. No equipment, except that used in spreading and mixing, will be allowed to pass over the freshly spread cement until it is mixed with the soil. Replace all spread cement that has been displaced before mixing is started at no cost to the Department.

542-8 MIXING

Immediately after the cement has been spread, mix it with the loosened soil material for the full depth of the treatment until a homogenous and uniform mixture is produced. Mixing will be considered sufficient when 100% of the mixture passes a 1/2" sieve and a minimum of 80% passes a No. 4 sieve, exclusive of any aggregate.

Immediately after mixing the soil and cement, add any additional water that is necessary to bring the moisture content between optimum and optimum plus 2% as determined by the Engineer. If moisture content exceeds the specified range, the soil-cement mixture may, if approved by the Engineer, be manipulated by remixing or blading to reduce the moisture content to within the specified range. Avoid excessive concentrations of water as well as wet spots or streaks on or near the surface. After all mixing water has been applied, continue mixing until a uniform mixture is obtained at the required moisture content. Perform the operations of cement spreading, water application, and mixing so that they result in a uniform soil, cement, and water mixture for the full depth and width of the area being treated. Remix any soil and cement mixture that has not been compacted and finished within 30 minutes.

542-9 COMPACTION

Begin compaction of the mixture immediately after the mixing operation is completed. At the start of compaction, make sure that the percentage of moisture in the mixture is no more than 2 percentage points above or below the optimum moisture content, and is less than the quantity which will cause the soil-cement mixture to become unstable during compaction and finishing. Compact the mixture to at least 97% of that obtained by a moisture-density test using AASHTO T134 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit.

Prior to compaction, prepare the mixture in a loose condition for its full depth. Compact the loose mixture uniformly to the specified density. During the compaction operations, initial shaping may be required to obtain uniform compaction and required grade and cross-section.

542-10 FINISHING

When initial compaction is nearing completion, shape the surface of the soil-cement to the required lines, grades, and cross-section. Maintain the moisture content of the surface material at not less than optimum during finishing operations.

If necessary, lightly scarify the surface to remove any tire imprints or smooth surfaces left by equipment. Continue compaction until a uniform and adequate density is obtained.

Perform the compaction and finishing in such a manner as to produce a dense surface free of compaction planes, cracks, ridges, or loose material.

When rain causes excessive moisture, reconstruct the entire section. Where such reconstruction is necessary, furnish all work and cement required at no cost to the Department.

542-11 THICKNESS

The compacted thickness of the completed soil-cement base will be determined by measurements made in test holes located at random intervals not to exceed 500 feet. Construct the soil-cement base so that the measured thickness does not deviate from that shown on the plans by more than plus 1" or minus 1/2".

Where the base is deficient in thickness by more than 1/2", remove and replace the area of deficient base with base of the required thickness at no cost to the Department.

As an exception to the above, if the deficiency is not considered sufficient to seriously impair the required strength of the soil-cement base, the deficient area may, at the discretion of the Engineer, be left in place. However, only 50% payment will be made for the base and the theoretical amount of cement used.

542-12 CURING

After the cement treated base has been finished as specified herein, cure it in accordance with Section 543.

542-13 CONSTRUCTION JOINTS

At the end of each day's construction, form a straight transverse construction joint by cutting back into the completed work to form a true vertical face.

Build soil-cement for large wide areas in a series of parallel lanes of convenient length and width meeting the approval of the Engineer. Form straight longitudinal joints at the edge of each day's construction by cutting back into completed work to form a true vertical face free of loose or shattered material.

Construct joints to provide a vertical joint having adequately mixed properly compacted material immediately adjacent to the joint. A longitudinal joint adjacent to partially hardened soil-cement built the preceding day may be formed by cutting back into the previously constructed area during mixing operations. Set guide stakes for cement spreading and mixing if deemed necessary.

542-14 TRAFFIC

Completed sections of the base may be opened when necessary to light-weight local traffic, provided the base has hardened sufficiently to prevent marring or distorting of the surface, and provided the curing is not impaired. Do not use construction equipment on the base for hauling except as necessary to discharge into the spreader during paving operations.

542-15 MAINTENANCE

Maintain the soil-cement base in an acceptable condition until final acceptance of the project. Include in maintenance operations immediate repair of any defects or damage that may occur. Perform this work at no cost to the Department and repeat as often as may be necessary to keep the base in an acceptable condition. Perform repairs to the base by replacing the base for its full depth rather than by adding a thin layer of soil-cement mixture to the existing layer of base.

542-16 MEASUREMENT AND PAYMENT

Soil-Cement Base will be measured and paid for at the contract unit price per square yard that has been completed and accepted. In measuring this quantity, the width of the base will be measured across the top surface of the base. The length will be the actual length constructed, measured along the centerline of the surface of the base.

Portland Cement for Soil-Cement Base will be paid for at the contract unit price per ton that has been incorporated into the mix. When bulk cement is used, the quantity will be measured by weighing in trucks on certified platform scales or other certified weighing devices. Measurement will not be made of any cement added or replaced for corrective measures during construction or for repairing damaged areas.

Asphalt curing seal will be paid for as provided in Article 543-5.

Blotting sand will be paid for as provided in Article 818-4.

Payment will be made under

Pay Item	Pay Unit
Soil-Cement Base	Square Yard
Portland Cement for Soil-Cement Base	Ton

SECTION 543
ASPHALT CURING SEAL

543-1 DESCRIPTION

Perform the work covered by this section including but not limited to keeping the stabilized layer moist; furnishing and applying the asphalt curing seal; correcting, maintaining, and repairing the asphalt curing seal; and blotting sand where directed, to either a chemically stabilized soil layer or to a cement stabilized base course. Perform this work in conformity with the contract.

543-2 MATERIALS

Refer to Division 10

Item	Section
Asphalt, Grade RS-1	1020-6
Asphalt, Grade RS-1H	1020-6
Asphalt, Grade CRS-1	1020-7
Asphalt, Grade CRS-1H	1020-7
Asphalt, Grade CRS-2	1020-7

543-3 EQUIPMENT

Use equipment to apply the asphalt material that meets the requirements of Article 600-5.

Use equipment to apply water, curing seal, and blotting sand that is of such type and weight that it will not damage the completed stabilized layer.

543-4 CONSTRUCTION REQUIREMENTS

Continuously moisten the finished stabilized layer or base course until the asphalt curing seal is placed. Place the curing seal as soon as possible, but no later than 24 hours after completing finishing operations except where delayed by wet weather. If wet weather delays application of the curing seal, apply the curing seal as soon as the surface becomes sufficiently dry.

At the time the asphalt curing seal is applied, prepare the surface of the stabilized layer or base so that it is free of all loose or extraneous material, and contains sufficient moisture to prevent excessive penetration of the asphalt material. If deemed necessary, sweep the base surface clean of loose material prior to applying the curing seal. Apply the curing seal in accordance with Section 600.

Apply the asphalt material to the surface of the completed stabilized layer or base at the rate of 0.10 to 0.20 gallons per square yard with approved equipment. Apply the asphalt material at the exact rate and temperature of application as established by the Engineer.

Cure the asphalt material for a period of 7 days. Curing time will be counted in not less than 1/2 day units and only when the air temperature in the shade is at least 50^{o}F. Complete the curing prior to placement of subsequent layers of pavement.

Maintain the curing material during the curing period so that all of the stabilized layer or base will be covered effectively during the period. Provide sufficient protection from freezing to the stabilized layer or base during the entire curing period and until it has hardened. Replace excessive loss of curing seal caused by heavy rains within 8 hours of placement at no cost to the Department.

Should the Engineer determine that it is necessary to allow local traffic to use parts of the stabilized layer or base before the asphalt material has cured sufficiently, protect those areas by applying blotting sand in accordance with Section 818.

543-5 MEASUREMENT AND PAYMENT

Asphalt Curing Seal will be measured and paid for at the contract unit price per gallon that has been placed on the stabilized layer or base. Seal material placed on the stabilized layer or base in excess of the authorized rate plus 0.02 gallon per square yard will not be measured for payment. Measurement will not be made of any curing seal used to replace curing seal lost by heavy rains which occur after placing the curing seal.

Blotting sand will be paid for as provided for in Article 818-4.

Payment will be made under

Pay Item	Pay Unit
Asphalt Curing Seal	Gallon

SECTION 545
INCIDENTAL STONE BASE

545-1 DESCRIPTION

Perform the work covered by this section including but not limited to furnishing, hauling, placing and shaping a graded stone material for use in driveways, temporary maintenance of traffic, adjacent to mailboxes, beneath traffic island, median covers and at any other locations, other than use as a part of any base course on which pavement is to be placed; shaping; tamping when required; maintaining the base; and disposing of any surplus stockpiled material.

545-2 MATERIALS

Use stone or gravel for the graded stone material which is well graded from the 1 1/2" through the No. 200 sieve sizes that conforms to the requirements of Article 1006.

545-3 GRADATION SAMPLING, TESTING, AND ACCEPTANCE

Acceptance of the graded stone material will be made by visual inspection and approval by the Engineer as being satisfactory for the purpose intended prior to its use. No sampling or testing of the graded stone material will be performed.

545-4 PLACING AND SHAPING STONE

Spread the stone material uniformly over the area required and then shape and dress to the satisfaction of the Engineer.

Uniformly spread, grade to the required depth, and firmly tamp the stone material beneath traffic island and median covers. If the Contractor desires, the surface of the stone material may be covered with a sufficient amount of fine material to facilitate grading and shaping.

545-5 MAINTENANCE

Maintain the stone material until final acceptance of the project by reshaping and by the addition of incidental stone base material when directed by the Engineer.

Maintain all stone material beneath traffic islands and median covers in satisfactory condition until the covers are placed.

545-6 MEASUREMENT AND PAYMENT

Incidental Stone Base will be measured and paid for at the contract unit price per ton that has been stockpiled or incorporated into the completed and accepted work. This quantity will be measured as provided for in Article 520-11. Incidental stone base which has been stockpiled will not be measured more than one time.

Payment will be made under

Pay Item	Pay Unit
Incidental Stone Base	Ton

SECTION 560
SHOULDER CONSTRUCTION

560-1 DESCRIPTION

Perform the work covered by this section including but not limited to furnishing the source of the borrow; building; maintaining, and obliterating haul roads; clearing and grubbing the borrow source; removal, hauling, and disposition of overburden and other unsuitable material; excavation; hauling; formation of roadway shoulders include the reshaping and finishing of slopes adjacent to the shoulders and roadway ditches; restoration of the source and haul roads to an acceptable condition; disposal of surplus stockpiled material; and seeding and mulching.

560-2 MATERIALS

Use soil consisting of loose, friable, sandy material free of subsoil admixtures, refuse, stumps, rocks, roots, root mats, or other unsatisfactory material.

Use soil with a P.I. greater than 6 and less than 25 and with a pH ranging from 5.5 to 6.8. Remove stones and other foreign material 2" or larger in diameter. All soil is subject to testing and acceptance or rejection by the Engineer.

Use Engineer approved material in the construction of earth shoulders, which has been obtained from unclassified excavation, fine grading operations, or from borrow sources as provided in Section 230.

560-3 CONSTRUCTION METHODS

Construct the top 6 in. of shoulders with soils capable of supporting vegetation.

Construct the shoulders in proper sequence with the type of base and pavement being constructed. Perform the work in such a manner as to provide proper drainage at all times. Shape and roll the shoulder material during placement in such a manner as will provide for satisfactory bonding of layers and compacted to a degree satisfactory to the Engineer.

Prior to placing any earth material on existing graded shoulders, remove all existing vegetation and scarify the existing shoulders to ensure a proper bond.

Perform the final shaping of the shoulders, adjacent slopes, and ditches in accordance with the typical section shown on the plans.

Provide adequate equipment to perform the work. Exercise care not to damage base, surface, pavement, or drainage features during the construction of the shoulders. Should damage occur because of the Contractor's operations, repair the damaged portions or remove and replace them as directed at no cost to the Department.

560-4 MEASUREMENT AND PAYMENT

(A) General

Shoulder borrow will be measured in its original position or in the haul truck, as directed by the Engineer.

No measurement will be made of material transported directly from unclassified excavation or fine grading and deposited directly in the place on the shoulder.

The quantity of shoulder borrow will be paid for at the contract unit price per cubic yard for "Shoulder Borrow", except as otherwise provided below.

(B) Measured in Original Position

The quantity of shoulder borrow to be paid for will be the actual number of cubic yards of approved material, measured in its original position in the borrow source or stockpile by cross sectioning and computed by the average end area method, which has been incorporated into the completed and accepted work. No measurement will be made of any overburden or unsuitable material removed from the borrow source, nor of any material excavated prior to cross sections being taken.

(C) Truck Measurement

The quantity of shoulder borrow to be paid for will be the actual number of cubic yards of approved material, measured in trucks, which has been incorporated into the completed and accepted work. Each truck will be measured by the Engineer and shall bear a legible identification mark indicating its capacity. Load each truck to at least its measured capacity at the time it arrives at the point of delivery. The recorded capacity will be adjusted by making a 25 percent deduction to allow for shrinkage, and the adjusted capacity will be the quantity to be paid for.

When shoulder material is obtained as a result of fine grading operations, trenching out existing subgrade, and/or shaping slopes and ditches, no direct payment will be made for the work of shoulder construction as such work will be considered incidental to the work of constructing the base or pavement.

No payment will be made for the removal and disposal of any surplus material remaining in the stockpile after the shoulders have been completed.

Where the borrow source has been furnished by the Department, payment for clearing and grubbing the source will be made as provided in Article 200-7 and payment for draining the source will be made as provided in Article 240-4. Where the source has been furnished by the Contractor, no separate payment will be made for clearing and grubbing or draining the source as such work will be considered as incidental to the work covered by this section.

Payment for seeding and mulching all borrow sources will be made at the contract unit prices for the items established in the contract as payment for the work of seeding and mulching.

Payment will be made under

Pay Item	**Pay Unit**
Shoulder Borrow	Cubic Yard

DIVISION 6
ASPHALT PAVEMENTS

SECTION 600
PRIME COAT

600-1 DESCRIPTION

Perform the work covered by this section including but not limited to treating an existing non-asphalt base course with asphalt material by furnishing and applying the prime, furnishing and placing granular material to protect the prime, and maintaining the prime coat in accordance with these Specifications.

Treat all non-asphalt bases beneath an asphalt surface treatment with a prime coat.

600-2 MATERIALS

Use materials for prime coat application that are on the Department's Approved Product List for Materials used for Prime Coat Applications and meet the requirement shown below.

Refer to Division 10

Item	Section
Prime Coat Materials	1020-3

These materials shall meet the manufacturer's specifications as submitted to and approved by the Department. This list is on file at the Materials and Tests Unit.

Where the grade of prime coat material is not established by the contract documents, the Contractor may select the grade to be used from the approved list. All prime coat materials shall be delivered to the project ready for use.

600-3 WEATHER LIMITATIONS

Apply prime coat only when the surface to be treated is sufficiently dry and the atmospheric temperature in the shade away from artificial heat is 40°F or above for plant mix, and 50°F or above for asphalt surface treatment.

Do not apply prime coat on a frozen surface or when the weather is foggy or rainy.

600-4 BASE PREPARATION

Clean the base of objectionable debris, excessive dust, and any other deleterious matter prior to placing the prime coat.

When directed, dampen the surface of the base prior to application of the prime coat.

600-5 APPLICATION EQUIPMENT

Provide, maintain, and operate a pressure distributor that is designed and equipped such that the asphalt material remains at a constant temperature and may be applied uniformly on variable widths of surface at predetermined and controlled rates. Use a distributor equipped with a tachometer or synchronizer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a mounted thermometer for measuring temperature.

Utilize a distributor equipped with a power driven pump of sufficient capacity to distribute the required quantity of asphalt material at constant flow and uniform pressure. Provide a full circulation spray bar adjustable laterally and vertically and adjustable in length to conform to the required width of application without overlapping. Provide and maintain nozzles designed to provide equal and uniform application at all times. Provide a hand spray hose and nozzle to cover areas inaccessible to the spray bars. Equip the distributor with a positive shut-off control for the spray bar and hand hose.

600-6 APPLICATION RATES AND TEMPERATURES

Apply the prime coat at a rate from 0.20 to 0.50 gallons per square yard. The exact rate for each application will be established by the Engineer prior to application, in accordance with the limits shown in the approved products list referenced in Article 600-2.

The required rate of application of asphalt materials will be based on the volume of material measured at the application temperature. Apply the prime coat material at a temperature that is in accordance with the manufacturer's recommendations or as approved.

600-7 APPLICATION OF PRIME COAT

When the plans require the base course to be constructed with side slopes flatter than 1:1, apply prime to the full width of the base including the side slopes.

Apply the prime coat only when the base to be treated has been approved.

Place a string line to provide alignment control for the distributor during prime coat application unless waived by the Engineer.

Cover bridge floors, curbs, and handrails of structures and all other appurtenances to protect them from tracking or splattering of prime coat.

After the prime coat has penetrated sufficiently and when directed, roll the primed surface until all loose base material is thoroughly bonded.

600-8 MAINTENANCE AND PROTECTION

Allow the prime coat to thoroughly penetrate the base. When directed, apply blotting sand in accordance with the requirements of Section 818.

Maintain the prime coat in an acceptable condition until such time as the pavement is placed. Replace any damaged prime coat at no cost to the Department.

600-9 MEASUREMENT AND PAYMENT

Have the volume of the distributor tank calibrated by a commercial laboratory or the manufacturer prior to use. Provide a calibration chart with an accurately calibrated measuring stick graduated in increments of not more than 25 gallons on the distributor at all times for use by the Engineer.

Prime will be determined by measuring the material at the actual application temperature and free from air bubbles. Deductions will be made from each measured tank of material for all material placed on the roadway that exceeds the application rate established by the Engineer by more than 0.03 gallons per square yard.

Prime Coat will be paid at the contract unit price per gallons of prime coat material that has been satisfactorily placed on the roadway. Each distributor load of prime coat material delivered and utilized on the project will be measured.

Blotting sand will be paid for in accordance with Article 818-5.

Payment will be made under:

Pay Item	Pay Unit
Prime Coat	Gallon

SECTION 605
ASPHALT TACK COAT

605-1 DESCRIPTION

Apply tack coat material to existing asphalt or concrete surfaces in accordance with these Specifications.

Apply tack coat beneath each layer of asphalt plant mix to be placed, unless otherwise approved. Where a prime coat or a newly placed asphalt surface treatment mat coat has been applied, apply tack coat as directed.

605-2 MATERIALS

Refer to Division 10

Item	Section
Asphalt Binder, Grade PG 64-22	1020-2
Emulsified Asphalt, Grade RS-1H	1020-6
Emulsified Asphalt, Grade CRS-1H	1020-7
Emulsified Asphalt, Grade CRS-1	1020-7
Emulsified Asphalt, Grade HFMS-1	1020-6
Emulsified Asphalt, Grade CRS-2	1020-7

Do not dilute or mix the tack coat material with water, solvents, or other materials prior to application.

Unless otherwise specified in the contract, the Contractor may utilize any of the grades of tack coat material specified in this article.

When tack coat is required beneath an open-graded asphalt friction course, the asphalt grade and rate of application to be used on the project will be specified on the job mix formula in accordance with Section 650.

605-3 WEATHER LIMITATIONS

Apply tack coat only when the surface to be treated is sufficiently dry and when the atmospheric temperature in the shade away from artificial heat is 35°F or above.

Do not apply tack coat when the weather is foggy or rainy.

605-4 SURFACE PREPARATION

Clean the existing asphalt or concrete surface to that tack coat is to be applied of all dust and foreign material prior to placing the tack coat.

Remove grass, dirt, and other materials from the edge of the existing pavement prior to the placement of tack coat.

605-5 ACCEPTANCE OF ASPHALT MATERIALS

The acceptance of asphalt materials will be in accordance with the requirements of Article 1020-1.

605-6 APPLICATION EQUIPMENT

Provide equipment for heating and uniformly applying the asphalt material in accordance with the requirements of Article 600-5.

605-7 APPLICATION RATES AND TEMPERATURES

Apply tack coat uniformly at a rate from 0.04 to 0.08 gallons per square yard. The exact rate for each application will be established by the Engineer. A different rate of application for different layers or surfaces may be established.

The established rates of application will be based on the volume of material at the actual application temperature. Apply tack coat at a temperature within the ranges shown in Table 605-1.

TABLE 605-1
APPLICATION TEMPERATURE FOR TACK COAT

Asphalt Material	Temperature Range
Asphalt Binder, Grade PG 64-22	375- 425°F
Emulsified Asphalt, Grade RS-1H	90-150°F
Emulsified Asphalt, Grade CRS-1	90-150°F
Emulsified Asphalt, Grade CRS-1H	90-150°F
Emulsified Asphalt, Grade HFMS-1	90-160°F
Emulsified Asphalt, Grade CRS-2	125-185°F

605-8 APPLICATION OF TACK COAT

Apply only as much tack coat material as can be covered with base, intermediate, or surface course material during the next day's operation except where public traffic is being maintained.

Where public traffic is being maintained, apply only as much tack coat as can be covered during the same day's operation. In addition, the Engineer may limit the application of tack coat in advance of the paving operation depending on traffic conditions, project location, proximity to business or residential areas, or other reasons. In the event that tack coat material is not covered in the same day's operation, the Engineer may require the application

of suitable granular material or other means to provide a safe traffic condition at no additional cost to the Department.

Take necessary precautions to limit the tracking and/or accumulation of tack coat material on either existing or newly constructed pavements. Excessive accumulation of tack may require corrective measures.

Apply tack coat material with a distributor spray bar that can be adjusted to uniformly coat the entire surface at the directed rate. Use a hand hose attachment only on irregular areas and areas inaccessible to the spray bar. Cover these areas uniformly and completely.

Apply tack coat as directed by and in the presence of the Engineer. Do not place any asphalt mixture until the tack coat has sufficiently cured.

Paint or spray contact surfaces of headers, curbs, gutters, manholes, vertical faces of old pavements, and all exposed transverse and longitudinal edges of each course with tack coat before mixture is placed adjacent to such surfaces.

Cover bridge floors, curbs, and handrails of structures, and all other appurtenances to protect them from tracking or splattering tack coat material.

605-9 PROTECTION OF TACK COAT

After the tack coat has been applied, protect it until it has cured for a sufficient length of time to prevent it from being picked up by traffic.

605-10 MEASUREMENT AND PAYMENT

There will be no direct payment for the work covered by this section.

Payment at the contract unit prices for the various mix items covered by Sections 610, 650, and 654 will be full compensation for all work covered by this section.

SECTION 607
MILLING ASPHALT PAVEMENT

607-1 DESCRIPTION

Perform the work covered by this section including but not limited to milling and re-milling the pavement at locations, depths, widths, and typical sections indicated in the contract documents, cleaning the milled surface, loading, hauling, stockpiling the milled material for use in recycled asphalt mixtures, and disposal of any excess milled material.

Except where the milled material is used in the work, provide areas outside the right of way to dispose of milled material, which becomes property of the Contractor.

607-2 EQUIPMENT

Use a self-propelled unit capable of removing the existing asphalt pavement to the depths, widths, and typical sections shown in the contract. Use milling machines designed and built exclusively for pavement milling operations and with sufficient power, traction,

and stability to accurately maintain depth of cut and slope. Use milling machines equipped with an electronic control system that will automatically control the longitudinal profile and cross slope of the milled pavement surface through the use of either a mobile grade reference(s), an erected string line(s), joint matching shoe(s), slope control systems, or other methods or combination of approved methods. Use an erected fixed stringline when required by the contract; otherwise, use a mobile grade reference system capable of averaging the existing grade or pavement profile over a minimum 30 foot distance or by non-contacting laser or sonar type ski systems with at least four referencing stations mounted on the milling machine at a minimum length of 24 feet. Coordinate the position of the grade control system such that the grade sensor is at the approximate midpoint of the mobile reference system. Use a machine capable of leaving a uniform surface suitable for handling traffic without excessive damage to the underlying pavement structure. Use a milling machine and other loading equipment capable of loading milled material to be used in other parts of the work without excessive segregation.

Provide additional equipment necessary to satisfactorily remove the pavement in the area of manholes, water valves, curb and gutter, and other obstructions.

Equip the milling equipment with a means of effectively limiting the amount of dust escaping from the removal operation in accordance with local, State, and Federal air pollution control laws and regulations.

607-3 CONSTRUCTION REQUIREMENTS

Mill the existing pavement in a manner that will restore the pavement surface to a uniform longitudinal profile and cross section in accordance with typical sections shown in the plans. Where indicated in the contract, remove pavement to a specified depth and produce a specified cross slope. Mill intersections and other irregular areas as indicated in the contract.

The Contractor may elect to make multiple cuts to achieve the required depth of cut or cross slope required by the plans.

Establish the longitudinal profile of the milled surface by a mobile string line on the side of the cut nearest the centerline of the road. Establish the cross slope of the milled surface by an automatic cross slope control mechanism or by a second skid sensing device located on the opposite edge of the cut. The Engineer may waive the requirement for automatic grade and cross slope controls where conditions warrant.

Operate the milling equipment in such a manner as to prevent damage to the underlying pavement structure, utilities, drainage facilities, curb and gutter, paved surfaces outside the milled area, and any other appurtenances. Produce milled pavement surfaces that are reasonably smooth and free of excessive scarification marks, gouges, ridges, continuous grooves, or other damage. Repair any leveling or patching required as a result of negligence by the Contractor with hot asphalt plant mix at no cost to the Department and in a manner acceptable to the Engineer. Coordinate the adjustment of manholes, meter boxes, and valve boxes with the milling operation.

The Engineer may require re-milling of any area exhibiting laminations or other defects. If the defects are determined to be the result of the Contractor's negligence, then

measurement for the re-milling, as specified in Article 607-5, will not be made. If however, the Engineer directs the re-milling of an area that is not due to the Contractor's negligence, measurement of the re-milled area will be made under requirements of Article 607-5.

Thoroughly clean the milled pavement surface of all loose aggregate particles, dust, and other objectionable material. Disposing or wasting of oversize pieces of pavement or loose aggregate material will not be permitted within the right of way.

Conduct pavement removal operations in a manner that effectively minimizes the amount of dust being emitted. Plan and conduct the operation so it is safe for persons and property adjacent to the work including the traveling public.

607-4 TOLERANCE

Remove the existing pavement to the depth required by the contract. The Engineer may vary the depth of milling by not more than one inch. In the event the directed depth of milling per cut is altered by the Engineer more than one inch, either the Department or the Contractor may request an adjustment in unit price under the requirements of Article 104-3. In administering the requirements of Article 104-3 the Department will give no consideration to value given to reclaimed asphalt pavement.

The Department will give no consideration to value given to reclaimed asphalt material due to the deletion or reduction in quantity of milling.

The requirements of Article 104-3 will not apply to the item of Incidental Milling.

607-5 MEASUREMENT AND PAYMENT

(A) General

Milled asphalt pavement to be paid for will be the actual number of square yards of pavement surface that has been milled in accordance with the requirements of this Section. In measuring this quantity, the length will be the actual length milled, measured along the pavement surface. The width will be the width required by the plans or directed, measured along the pavement surface.

Where the depth of milling varies from the required depth, no adjustment in the contract unit price for *Milling Asphalt Pavement, _____ Inch Depth* will be made except as provided in Article 607-4.

(B) Milling Asphalt Pavement, _____ Inch Depth

For each and every square yard that the Engineer directs to be milled; including that requiring any additional equipment necessary to remove pavement in the area of manholes, water valves, curb and gutter, and other obstructions; measured as provided in Subarticle 607-5(A); compensation will be made at the contract unit price per square yard for *Milling Asphalt Pavement, _____ Inch Depth*.

Where the Engineer directs multiple cuts to achieve the final depth, measurement will be made for each cut. Where the Contractor elects to make multiple cuts to achieve the final depth, no additional measurement will be made.

(C) Incidental Milling

Where the Contractor is required by the plans to mill irregular areas and intersections or is directed to re-mill areas whose length is less than 100 feet, measurement will be made as provided in Subarticle 607-5(A) for each cut he is directed to perform. Where the Contractor elects to make multiple cuts to achieve the final depth, no additional measurement will be made. Compensation will be made at the contract unit price per square yard for *Incidental Milling*.

Payment will be made under:

Pay Item	Pay Unit
Milling Asphalt Pavement, __" to ___"	Square Yard
Milling Asphalt Pavement, __" Depth	Square Yard
Incidental Milling	Square Yard

SECTION 609
QUALITY MANAGEMENT SYSTEM FOR ASPHALT PAVEMENTS

609-1 DESCRIPTION

Produce and construct asphalt mixtures and pavements in accordance with a quality management system as described in these Specifications. Apply these Specifications to all materials and work performed in accordance with Division 6. Perform all quality control activities in accordance with the Department's *Hot Mix Asphalt Quality Management System (HMA/QMS) Manual* in effect on the date of contract advertisement, unless otherwise approved.

609-2 DESCRIPTION OF RESPONSIBILITIES

(A) Quality Control (QC)

Provide and conduct a quality control program in accordance with Article 609-5 and these Specifications. A quality control program is defined as all activities, including mix design, process control inspection, plant and equipment calibration, sampling and testing, and necessary adjustments in the process that are related to production of a pavement that meets all requirements of the Specifications.

(B) Quality Assurance (QA)

The Department will conduct a quality assurance program in accordance with Article 609-6 and these Specifications. A quality assurance program is defined as all activities, including inspection, sampling, and testing related to determining that the quality of the completed pavement conforms to specification requirements.

609-3 MIX DESIGN/JOB MIX FORMULA REQUIREMENTS

Apply all requirements of Article 610-3.

609-4 FIELD VERIFICATION OF MIXTURE AND JOB MIX FORMULA ADJUSTMENTS

Conduct field verification of the mix at each plant within 30 calendar days prior to initial production of each mix design, when required by the Allowable Mix Adjustment Policy and when directed as deemed necessary.

Field verification testing consists of performing a minimum of one full test series on mix sampled and tested in accordance with Subarticle 609-5(C)2, Required Sampling and Testing Frequencies. Mix obtained from NCDOT or non-NCDOT work may be used for this purpose provided it is sampled, tested, and the test data handled in accordance with current procedures in the Department's HMA/QMS Manual and the following provisions.

Obtain the mix verification sample and split in accordance with current procedures in the Department's HMA/QMS Manual. Do not begin normal plant production until all field verification test results have been completed and the mix has been satisfactorily verified by the Contractor's Level II Technician. Verification is considered satisfactory when all volumetric properties except %Gmm@Nini are within the applicable mix design criteria and the gradation, binder content, and %Gmm@Nini are within the individual limits for the mix type being produced.

In addition to the required sampling and testing for field verification, perform all preliminary inspections and plant calibrations as outlined in the HMA/QMS Manual.

Retain records of these calibrations and mix verification tests, including Superpave Gyratory Compactor (SGC) printouts, at the QC laboratory. In addition, furnish copies, including SGC printouts, to the Engineer for review and approval within one working day after beginning production of the mix.

Conduct the initial mix verification of all new mix designs with the plant set up to produce the aggregate blend and binder content in accordance with the initially approved JMF. If the Contractor and/or the Engineer determine from results of quality control tests conducted during mix verification that adjustments to the JMF are necessary to achieve specified mix properties, adjustments to the JMF may be made within tolerances permitted by Specifications for the mix type being produced, subject to approval. No reduction of asphalt binder content will be made when the average production VMA computes below the minimum specification requirement. All JMF adjustments will be approved by the Engineer and documented in writing.

Failure by the Contractor to fully comply with the above mix verification requirements will result in immediate production stoppage by the Engineer. Do not resume normal production until all mix verification sampling, testing, calibrations, and plant inspections have been performed and approved. Any mix produced that is not verified may be assessed a price reduction at the Engineer's discretion in addition to any reduction in pay due to mix and/or density deficiencies.

609-5 CONTRACTOR'S QUALITY CONTROL SYSTEM

(A) Personnel Requirements

Obtain all certifications in accordance with the Department's QMS Asphalt Technician Certification Program as outlined in the *HMA/QMS Manual*. Perform all sampling, testing, data analysis and data posting by or under the direct supervision of a certified QMS asphalt plant technician.

Provide a certified Asphalt Plant Technician Level I to perform quality control operations and activities at each plant site at all times during production of material for the project. A plant operator who is a certified Asphalt Plant Technician Level I may be utilized to meet this requirement when daily production for each mix design is less than 100 tons provided the randomly scheduled increment sample as defined in Article 609-5(C)2 is not within that tonnage. When performing in this capacity, the plant operator will be responsible for all quality control activities that are necessary and required. Absences of the Level I Technician, other than those for normal breaks and emergencies shall be pre-approved by the appropriate QA Supervisor or his designated representative. Any extended absence of the Technician that has not been approved will result in immediate suspension of production by the Engineer. All mix produced during this absence will be accepted in accordance with Article 105-3.

Provide and have readily available a certified Asphalt Plant Technician Level II to supervise, coordinate, and make any necessary adjustments in the mix quality control process in a timely manner. The Level II Technician may serve in a dual capacity and fulfill the Level I Technician requirements specified above.

Provide a certified QMS Roadway Technician with each paving operation at all times during placement of asphalt. This person is responsible for monitoring all roadway paving operations and all quality control processes and activities, to include stopping production or implementing corrective measures when warranted. Provide a certified nuclear gauge operator when nuclear density control is being used.

Post in the quality control laboratory an organizational chart, including names, telephone numbers and current certification numbers of all personnel responsible for the quality control program while asphalt paving work is in progress.

(B) Field Laboratory Requirements

For a contract with 5000 or more total tons of asphalt mix, furnish and maintain a Department certified laboratory at the plant site. A minimum of 320 square feet of floor space (exclusive of toilet facilities), equipment, and supplies necessary for performing Contractor quality control testing is required. Provide convenient telephone and fax machine access for QMS personnel at the plant site.

For a contract with less than 5000 total tons of asphalt mix, the quality control testing may be conducted in a Department certified off-site laboratory. All other requirements in these Specifications still apply.

Provide testing equipment meeting the requirements of the test methods herein identified in Subarticle 609-5(C)2. Provide equipment that is properly calibrated and maintained. Allow all measuring and testing devices to be inspected to confirm both calibration and condition. If at any time the Engineer determines that the equipment is not operating properly or is not within the limits of dimensions or calibration described in the applicable test method, the Engineer may stop production until corrective action is taken. Maintain and have available a record of all calibration results at the laboratory.

(C) Plant Mix Quality Control

(1) General

Include in the quality control process the preliminary inspections, plant calibrations and field verification of the mix and JMF as described in Article 609-4. In addition, conduct at a minimum but not limited to, the sampling, testing, and determination of all parameters outlined in these provisions using test methods and minimum frequencies as specified herein. Perform additional sampling and testing when conditions dictate. Obtain all scheduled samples at randomly selected locations in accordance with the current edition of the Department's *HMA/QMS Manual*. Log all samples taken on forms provided by the Department. Split and retain all samples taken in accordance with prescribed procedures in the *Manual*. Provide documentation as required in Subarticle 609-5(E). Identify any additional quality control samples taken and tested at times other than the regularly scheduled random samples or directed samples that take the place of regularly scheduled as process control (PC) samples on the appropriate forms. Process Control test results should not be plotted on control charts nor reported to Quality Assurance Laboratory.

Retain the untested split portion of quality control aggregate and mix samples and the tested TSR specimens for 5 calendar days at the plant site, commencing the day the samples are tested. Retain the QC compacted volumetric test specimens for 5 calendar days, commencing the day the specimens are prepared. Permission for disposal may be given by Quality Assurance personnel prior to these minimum storage periods. Retain the split portion of the Contractor’s mix verification and referee mix samples until either procured by or permission for disposal is given by Quality Assurance personnel. Store all retained samples in a dry and protected location.

(2) Required Sampling and Testing Frequencies

Maintain minimum test frequencies as established in the schedule below. Complete all tests within 24 hours of the time the sample is taken, unless specified otherwise within these provisions. Should the specified tests not be completed within the required time frame, cease production at that point until such time the tests are completed.

Should the Contractor’s testing frequency fail to meet the minimum frequency requirements as specified, all mix without the specified test representation will

be considered unsatisfactory. If the Engineer allows the mix to remain in place, payment will be made at 50 percent of the contract unit bid price for the mixture.

If desired, innovative equipment or techniques not addressed by these Specifications to produce or monitor the production of mix may be utilized, subject to approval.

QUALITY CONTROL MINIMUM SAMPLING AND TESTING SCHEDULE

Sample and test the completed mixture from each job mix formula at the following minimum frequency during mix production:

Accumulative Production Increment	Number of Samples per Increment
750 tons	1

If production is discontinued or interrupted before the accumulative production increment tonnage is completed, continue the increment on the next production day(s) until the increment tonnage is completed. Obtain a random sample within the specified increment at the location determined in accordance with the current edition of the Department's *HMA/QMS Manual*. Conduct quality control sampling and testing on each random sample as scheduled below. When daily production of each mix design exceeds 100 tons and a regularly scheduled full test series random sample location for that mix design is not reached during that day's production, perform at least one partial test series consisting of Items A and B in the schedule below. These partial test series and associated tests do not substitute for the regularly scheduled random sample for that increment.

Perform the following full test series on all regularly scheduled random samples:

Asphalt Mixture - Sampled From Truck at Plant (AASHTO T 168 Modified)(Split Sample Required)

(a) Binder Content, % (Contractor may select either option below):

  (i) Ignition Furnace (AASHTO T 308 Modified)

  (ii) Other (Contractor may request and use other means of determining percent asphalt binder, subject to approval).

(b) Gradation on Recovered Blended Aggregate from Mix Sample (AASHTO T 30 Modified) Grade on all sieves specified on JMF

(c) Maximum Specific Gravity (AASHTO T 209), optional (ASTM D 6857)

(d) Bulk Specific Gravity of Compacted Specimens (AASHTO T166), optional (ASTM D 6752), Average of 3 specimens at Ndes gyrations (AASHTO T 312)

(e) Air Voids (VTM) (AASHTO T 269), Average of 3 specimens at Ndes gyrations

(f) Voids in Mineral Aggregate (VMA) (calculation)

(g) Voids Filled with Asphalt (VFA) (calculation)

(h) P0.075/Pbe Ratio

(i) Percent Maximum Specific Gravity at Nini (calculation)

In addition to the above schedule, conduct the following sampling and testing as indicated:

(a) Aggregate Stockpile Gradations (AASHTO T 27 and T 11)

(Sampled from stockpiles or cold feed system as follows; split samples not required)

(i) Coarse Aggregates (Approved Standard Sizes)

a. At beginning of production*

b. Weekly thereafter*

(ii) Fine Aggregates (Stone Screenings, Natural Sands, Etc.)

a. At or within 1 week prior to mix verification (Gradations valid for multiple mix designs).

b. Weekly after mix verification*,

c. Anytime production is stopped due to plant mix gradation related problems.

*In lieu of the aggregate stockpile gradations performed by QC personnel, gradation quality control data conducted by the aggregate producer, that is representative of the Contractor's current stockpiles, may be furnished.

(b) Reclaimed Asphalt Pavement (RAP) Binder Content and Gradation (AASHTO T 308 Modified or T 164 and AASHTO T 30 Modified) (sampled from stockpiles or cold feed system at beginning of production and weekly thereafter). Have RAP approved for use in accordance with Subarticle 1012-1(G). (Split Sample Required)

(c) Reclaimed Asphalt Shingle Material (RAS) Binder Content and Gradation (AASHTO T 308 Modified or T 164 and AASHTO T 30 Modified) (sampled from stockpiles or cold feed system at beginning of production and weekly thereafter). Have RAS approved for use in accordance with Subarticle 1012-1(F). (Split Sample Required)

(d) Combined Aggregate Moisture Content (AASHTO T 255) Drum Plant Only (sampled from stockpiles or cold feed system a minimum of once daily).

(e) Retained Tensile Strength (TSR) - (AASHTO T 283 Modified):

Mix sampled from truck at plant, tested, and results furnished to the Engineer within 7 calendar days after beginning production of each new mix design. From the split sample, Quality Control personnel will prepare and submit within 5 calendar days of the sample date, an additional set of specimens to the QA Laboratory for TSR testing (Split Sample Required).

Specimens shall be tested on either a recording test press or a test press that maintains the peak load reading after the specimen has broken.

Additional TSR testing required prior to mix production in accordance with above procedures is required when a change is made in anti-strip additive dosage or when a new anti-strip additive source or grade is utilized, unless otherwise approved. Other TSR test(s) may be directed as deemed necessary. TSR testing is not required for mix verification, but may be performed at that time.

(3) Control Charts

Maintain standardized control charts furnished by the Department at the field laboratory. For mix incorporated into the project, record full test series data from all regularly scheduled random samples or directed samples that replace regularly scheduled random samples, on control charts the same day the tests are obtained.

In addition, partial test series results obtained due to reasons outlined in Subarticle 609-5(C)(2) will be reported to Quality Assurance personnel on the proper forms, but will not be plotted on the control charts.

Results of quality assurance tests performed by the Engineer will be posted on the Contractor's control charts as data becomes available.

Record the following data on the standardized control charts:

(a) Aggregate Gradation Test Results

  (i) For each mix type: one sieve size smaller than the mix nominal maximum size.

  (ii) For all mix types: 2.36 mm and 0.075 mm sieves

(b) Binder Content, %, Pb

(c) Bulk Specific Gravity of Compacted Specimens at Ndes (measured)

(d) Maximum Specific Gravity Determined by AASHTO T 209

(e) Percent Voids in Total Mix at Ndes Gyrations

(f) Percent Voids in Mineral Aggregate at Ndes Gyrations

(g) P0.075/Pbe Ratio

(h) Percent Maximum Specific Gravity at Nini Gyrations

Both the full test series individual test values and the moving average of the last 4 data points will be plotted on each chart. The Contractor's test data will be shown in black and the moving average in red. The Engineer's assurance data will be plotted in blue. Denote the warning control limits with a dash green line, the moving average control limits with a dash blue line, and individual test limits with a dash red line.

Maintain a continuous moving average with the following exceptions. Re-establish a new moving average only when:

(a) A change in the binder percentage or aggregate blend is made in the JMF, or,

(b) When the Contractor elects to stop or is required to stop production after one or two moving average values, respectively, fall outside the warning limits as outlined in Subarticle 609-5(C)6, or,

(c) If failure to stop production after two consecutive moving averages exceed the warning limits occurs, but production does stop at a subsequent time, re-establish a new moving average beginning at the actual production stop point.

In addition, re-establish the moving averages for all mix properties. Moving averages will not be re-established when production stoppage occurs due to an individual test result exceeding the individual test limits and/or Specifications.

All individual test results for regularly scheduled random samples or directed samples that replace regularly scheduled samples are part of the plant quality control record and shall be included in moving average calculations with the following exception. When the Contractor’s testing data has been proven incorrect, use the correct data as determined by the Engineer in lieu of the Contractor’s data to determine the appropriate pay factor in accordance with Subarticle 609-5(C)6. In this case, replace the data in question and any related data proven incorrect.

(4) Control Limits

The following are established as control limits for mix production. Control limits for the warning and moving average limits are based on a moving average of the last 4 data points. Apply all control limits to the applicable target source.

CONTROL LIMITS

Mix Control Criteria	Target Source	Warning Limit	Moving Average Limit	Individual Limit
2.36mm Sieve	JMF	±4.0 %	±5.0 %	±8.0 %
0.075mm Sieve	JMF	±1.5 %	±2.0 %	±2.5 %
Binder Content	JMF	±0.3 %	±0.5 %	±0.7 %
VTM @ N_{des}	JMF	±1.0 %	±1.5 %	±2.0 %
VMA @ N_{des}	Min. Spec. Limit	-0.5%	-0.8%	-1.0 %
$P_{0.075}$/ P_{be} Ratio	Max. Spec. Limit	0.0	N/A	+0.4%
$\%G_{mm}$ @ N_{ini}	Max. Spec. Limit	N/A	N/A	+2.0%
TSR	Min. Spec. Limit	N/A	N/A	-15.0%

(5) Warning Bands

Warning bands are defined as the area between the warning limits and moving average limits.

(6) Corrective Actions

Immediately notify the Engineer when moving averages exceed the warning limits. All required corrective actions are based upon initial test results and shall be taken immediately upon obtaining those results. In the event situations occur that warrant more than one corrective action and/or adjustment, give precedence to the more severe of these actions. Stopping production when required takes precedence over all other corrective actions. Document all corrective actions.

Immediately cease production and immediately notify the Engineer when any of the following occur:

(a) When an individual test result for a mix control criteria (including results for required partial test series on mix) exceeds both the individual test control limits and the applicable specification design criteria, or,

(b) When two consecutive field TSR values fail to meet the minimum specification requirement, or,

(c) When two consecutive binder content test results exceed the individual limits.

Do not resume normal plant production until one of the following has occurred.

Option 1: Approval has been granted by the appropriate QA Supervisor.

Option 2: The mix in question has been satisfactorily verified in accordance with Article 609-4. Normal production may resume based on the approval of the contractor's Level II technician, provided notification and the verification test results have been furnished to the QA Laboratory.

Failure to fully comply with one of the above provisions will result in immediate production stoppage by the Engineer. Normal production shall not then resume until a complete verification process has been performed and approved by the Engineer.

Acceptance of all mix failing to meet the individual test control limits (including results for required partial test series on mix) or minimum TSR requirements as described above will be determined in accordance with Article 105-3. In addition, any mix that is obviously unacceptable will be rejected for use in the work.

Failure to stop production when required due to an individual mix test not meeting the specified requirements will subject all mix from the stop point tonnage to the point when the next individual test is back on or within the warning limits, or to the tonnage point when production is actually stopped, whichever occurs first, to being considered unacceptable.

Failure to stop production when required due to two consecutive TSR tests failing to meet the specification requirements will subject all mix from the stop point tonnage to the point when the next TSR test meets or exceeds the specification requirement, or to the tonnage point when production is actually stopped, whichever occurs first, to being considered unacceptable.

In either case, remove and replace this mix with materials that comply with the Specifications at no additional costs to the Department, unless otherwise approved. Payment will be made for the actual quantities of materials required to replace the removed quantities, not to exceed the original amounts.

Immediately notify the Engineer when any moving average value exceeds the warning limit. If two consecutive moving average values for any one of the mix control criteria fall outside the warning limits, cease production of that mix, immediately notify the Engineer of the stoppage, and make adjustments. The Contractor may elect to stop production after only one moving average value falls outside the warning limits. In either case, do not determine a new moving average until the fourth test after the elective or mandatory stop in production.

Do not resume normal plant production until one of the following has occurred.

Option 1: Approval has been granted by the appropriate QA Supervisor.

Option 2: The mix in question has been satisfactorily verified in accordance with Article 609-4. Normal production may resume based on the approval of the contractor's Level II technician, provided notification and the verification test results have been furnished to the QA Laboratory.

Failure to fully comply with one of the above provisions will result in immediate production stoppage by the Engineer. Normal production shall not then resume until a complete verification process has been performed and approved by the Engineer.

If the process adjustment improves the property in question such that the moving average after four additional tests is on or within the warning limits, the Contractor may continue production with no reduction in payment.

If the adjustment does not improve the property in question such that the moving average after four additional individual tests stays in the warning bands, the mix will be considered not to be within reasonably close conformity, but reasonably acceptable. Reduced payment for the mix in question will be applied starting from the plant sample tonnage at the stop point to the sample tonnage when the moving average is on or within the warning limits in accordance with the following table.

Payment for Mix Produced in the Warning Bands*

Property		**Pay Factor**
2.36mm Sieve		90%
0.075mm Sieve		90%
Binder Content		85%
VTM @ N_{des}		70%
VMA @ N_{des}		90%

* When two or more properties are in question, only the lower pay factor will be applied to the mix unit bid price.

If the adjustment does not improve the property in question such that the moving average after four additional tests exceeds the moving average control limits, the mix will be considered not to be within reasonably close conformity with Specifications. If the Engineer determines the mix is reasonably acceptable based on test data and an inspection of the completed pavement and allows it to remain in place, the mix will be accepted in accordance with Article 105-3. If the mix is determined to be unacceptable, the mix will be removed and replaced with materials that comply with the Specifications. In either case, the adjustment or removal, respectively, for the mix in question will be applied starting from the plant sample tonnage at the stop point to the sample tonnage when the moving average is on or within the warning limits. In addition, any mix that is obviously unacceptable will be rejected for use in the work.

Failure to stop production and make adjustments when required due to two consecutive moving average values falling outside the warning limits will subject all mix produced from the stop point tonnage to the tonnage point when the moving average is back on or within the warning limits or to the tonnage point when production is actually stopped, whichever occurs first, to being considered unacceptable. Remove this material and replaced with materials which comply with the Specifications at no additional costs to the Department, unless otherwise approved. Payment will be made for the actual quantities of materials required to replace the removed quantities, not to exceed the original amounts.

(7) Allowable Retesting for Mix Deficiencies

The Contractor may elect to resample and retest for plant mix deficiencies when individual QC test(s) exceed one or more mix property target(s) by more than the tolerances indicated below. Perform the retesting within 10 days after initial test results are determined. Retesting shall be approved prior to being performed and in accordance with the Department's GUIDELINES FOR RETESTS OF PLANT MIX DEFICIENCIES outlined in the HMA/QMS Manual. The Contractor, under the supervision of the Department's QA personnel, will perform these retests. Retests for any mix deficiency other than as listed below will not be allowed unless otherwise permitted. Acceptance of the mix in question will be based on the retest data in accordance with Article 105-3.

The Department reserves the right to require the Contractor to resample and retest at any time or location as directed.

- VTM -- by more than +/- 2.5%
- VMA -- by more than +/- 2.0%
- % Binder Content -- by more than +/- 1.0%
- 0.075 mm sieve -- by more than +/- 3.0%
- 2.36 mm sieve -- exceeds both the Specification mix design limits and one or more of the above tolerances
- TSR -- by more than -15% from Specification limit

(D) Field Compaction Quality Control

(1) General

Perform quality control of the compaction process in accordance with these provisions and applicable requirements of Article 610-9. The Contractor may elect to use either cored sample density procedures or nuclear gauge density procedures. Provide to the Department at the pre-construction conference the method of density quality control that will be used on the project.

Establish acceptable control strips when required at locations approved by the Engineer. Construct control strips that are 300 feet in length at the paver laydown width being placed. When utilizing core sample control, place control strips anytime placement is proceeding on limited production due to failing densities. When utilizing nuclear density control, place control strips

at the minimum frequencies specified in the Department's current Nuclear Gauge Operator's Manual. In addition, place control strips anytime deemed necessary by the Engineer.

Conduct density sampling and testing by either method based on test sections consisting of not more than 2000 linear feet or fraction thereof per day on pavement placed at the paver laydown width. Perform density sampling and testing on all pavements listed below unless otherwise approved.

(a) All full width travel lane pavements, including normal travel lanes, turn lanes, collector lanes, ramps and loops, and temporary pavements,

(b) Pavement widening 4.0 feet or greater,

(c) Uniform width paved shoulders 2.0 feet or greater,

(d) and wedging as outlined in the *HMA/QMS Manual*.

Base and intermediate mix types (surface mixes not included) utilized for pavement widening of less than 4.0 feet and all mix types used in tapers, irregular areas and intersections (excluding full width travel lanes of uniform thickness), will not be subject to the sampling and testing frequency specified above provided the pavement is compacted using approved equipment and procedures. However, the Engineer may require occasional density sampling and testing to evaluate the compaction process. Irregular areas are defined as areas that have irregular shapes that make them difficult to compact with conventional asphalt rollers.

Perform the sampling and testing at the minimum test frequencies as specified above. Should the density testing frequency fail to meet the minimum frequency as specified above, all mix without the required density test representation will be considered unsatisfactory and if allowed to remain in place, will be paid for at 50 percent of the contract unit bid price for the mixture.

Conduct all QC nuclear density testing the same day that the mix being tested is placed and compacted. Obtain all core samples no later than the beginning of the next production day, not to exceed 3 calendar days. Test QC core samples and submit test results within one working day of the time the samples are taken. Should the specified density tests not be completed within the allowable time cease production at that point until such time the required tests are completed. Failure to provide samples may result in suspension of all project operations.

Retain quality control density core samples at the plant site for 5 calendar days, commencing the day the samples are tested, or until permission for disposal is granted by the quality assurance personnel, whichever occurs first. Retain the Department's quality assurance comparison and verification core samples in a sealed container at the plant site until obtained by quality assurance personnel. Store all retained density samples on a smooth, flat surface in a cool, dry, and protected location.

Check core samples may be taken by the Contractor for any of the following reasons:

(a) When core sample control is being used and a test section core sample(s) is more than 2.0 percent below the average of all core samples from the same lot, that core(s) samples may be checked,

(b) When a control strip fails and a core sample(s) is more than 2.0 percent below the average of the control strip, that core(s) may be checked.

For each core sample that is to be checked, take 3 check samples as follows: one adjacent to the initial sample and one ten feet in each direction, longitudinally, of the initial sample. The results of these 3 check samples will be averaged and this average will be used in lieu of the initial core results in question. The initial core sample results will not be used if check samples are taken.

Check samples shall be taken within 2 calendar days of the date of the initial sample. Only one set of check samples per sample location will be allowed. If full depth cores are necessary at these check sample locations, separation of the layer to be tested will be the responsibility of the Contractor. Take all check samples in the presence of a representative of the Engineer. In addition, a QA comparison core sample(s) may be taken adjacent to one or more of these check samples.

(2) Pavement Samples (Cores)

When cored samples are required by either density method, obtain cores from the full layer depth of the compacted pavement at random locations determined in accordance with procedures in the Department's HMA/QMS Manual. If full depth cores are taken, the Contractor is responsible for separating the layer of mix to be tested in a manner such that it is not damaged. The use of a separator medium beneath the layer to be tested is prohibited.

Pavement layers may be cooled by approved artificial methods to allow cutting the core samples as quickly as possible. No additional compensation will be made for the costs of artificial cooling.

Take pavement specimens for density testing purposes utilizing a 6 inch core drill. Use approved coring equipment that is capable of taking a representative sample of the compacted pavement. In the event a malfunction of the coring equipment occurs, utilize other approved means to obtain the required samples. Repair the coring equipment and restore to use within three working days.

Where samples have been taken, clean the inside surfaces of the sample hole, dry, properly apply tack coat, place and compact new mix of the same type to conform with the surrounding area within one working day of the sample being taken. Use a circular tamp or other approved device to achieve compaction.

(3) Core Sample Density Procedures

In addition to the above requirements, perform core sample density control procedures as noted herein. When cored sample control is being utilized, the testing frequency will be a minimum of one random 6 inch core sample taken from each test section, except take a minimum of at least three core samples from each mix type and/or lot placed on a given day.

An initial control strip is not required at the beginning of placement of each job mix formula but may be performed by the Contractor for use in determining the necessary compactive effort and roller patterns. Cored sample control strips will be required if production and placement is being performed under limited production procedures due to failing densities.

(4) Nuclear Gauge Density Procedures

In addition to the requirements in Subarticle 609-5(D)1, perform nuclear density control procedures in accordance with the Department's most current Nuclear Gauge Operator's Manual. This Manual may be obtained through the Department's M & T Soils Laboratory. Determine density by the backscatter method of testing using a thin-lift nuclear gauge, with printer, which has been approved by the Department. Furnish, maintain, and operate the nuclear gauge. Furnish an operator that has been certified by the Department.

Provide a gauge that has been calibrated within the previous 12 months by an approved calibration service. Maintain documentation of such calibration service for a 12 month period.

Conduct all QC nuclear density tests the same day the mix being tested is placed and compacted. Furnish summary of density results to the Engineer no later than the end of each day's production. Furnish a copy of the nuclear gauge printout(s) to the Engineer upon request.

Determine target density for testing by constructing control strip(s) in accordance with and at the frequencies prescribed in the Nuclear Gauge Operator's Manual. Core samples from the control strips may be checked in accordance with the criteria established in Subarticle 609-5(D)1.

Conduct sampling and testing as specified based on test sections consisting of not more than 2000 linear feet or fraction thereof per day on pavement placed at the paver laydown width. The nuclear density testing frequency will consist of five random gauge readings (one random reading from each of five equally spaced increments) from each test section. In addition, take at least five gauge readings during any day's production of a given mix type. Random locations for gauge readings will be determined in accordance with the procedures in the Department's most current Nuclear Gauge Operator's Manual. Test section pavement shall be of the same mix design as the pavement utilized in the applicable control strip.

(5) Limited Production Procedure

Proceed on limited production when, for the same mix type and contract, one of the following conditions occur:

(a) Two consecutive failing lots, excluding lots representing an individual resurfacing map or portion thereof.
(b) Three consecutive failing lots, with each lot representing an individual resurfacing map or portion thereof.
(c) Two consecutive failing nuclear control strips.

As exceptions to the above, pavement within each construction category (New and Other), as defined in Article 610-13, and pavement placed simultaneously by multiple paving crews will be evaluated independently for limited production purposes.

Limited production is defined as being restricted to the production, placement, and compaction of a sufficient quantity of mix necessary to construct only a 300 foot control strip plus 100 feet of pavement adjacent to each end of the control strip.

Remain on limited production until such time as satisfactory density results are achieved or until two control strips have been attempted without achieving acceptable density test results. If the Contractor fails to achieve satisfactory density after two control strips have been attempted, cease production of that mix type until such time as the cause of the failing density test results can be determined. As an exception, the Engineer may grant approval to produce a different mix design of the same mix type if the cause is related to mix problem(s) rather than compaction related problems.

If the Contractor does not operate by the limited production procedures as specified above, the two consecutive failing density lots, three consecutive failing lots with each lot representing an individual resurfacing map or portion thereof, or two consecutive failing nuclear control strips, whichever is applicable, and all mix produced thereafter will be considered unacceptable. Remove this material and replace with material that complies with the Specifications at no cost to the Department, unless otherwise approved. Payment will be made for the actual quantities of materials required to replace the removed quantities, not to exceed the original amounts.

(E) Documentation (Records)

Document all quality control activities, records of inspection, samples taken, adjustments to the mix, and test results on a daily basis. Note the results of observations and records of inspection as they occur in a permanent field record. Record adjustment to mix production and test results on forms provided. Process control sample test results are for the Contractor’s informational purposes only.

Make all such records available to the Engineer, upon request, at any time during project construction. Complete all QC records and forms and distribute in accordance with the most current edition of the Department's *HMA/QMS Manual*. Maintain all QC records, forms and equipment calibrations for a minimum of 3 years from their completion date. Failure to maintain QC records and forms as required, or

to provide these records and forms to the Engineer upon request, may result in production and/or placement stoppage until the problem is resolved.

Falsification of test results, documentation of observations, records of inspection, adjustments to the process, discarding of samples and/or test results, or any other deliberate misrepresentation of the facts will result in the revocation of the applicable person's QMS certification. The Engineer will determine acceptability of the mix and/or pavement represented by the falsified results or documentation. If the mix and/or pavement in question is determined to be acceptable, the Engineer may allow the mix to remain in place at no pay for the mix, asphalt binder and other mix components. If the mix and/or pavement represented by the falsified results is determined not to be acceptable, remove and replace with mix, that complies with the Specifications. Payment will be made for the actual quantities of materials required to replace the falsified quantities, not to exceed the original amounts.

609-6 QUALITY ASSURANCE

The Department's quality assurance program will be conducted by a certified QMS technician(s) and will be accomplished in the following ways:

Plant Mix Quality Assurance:

(A) By conducting assurance testing of split samples obtained by the Contractor at a frequency equal to or greater than 5%of the frequency required of the Contractor;

(B) By periodically observing sampling and testing procedures performed by the Contractor;

(C) By monitoring required control charts exhibiting test results of control parameters;

(D) By directing the Contractor to take additional samples at any time and any location during production (in lieu of the next scheduled random sample for that increment);

(E) By conducting verification sampling and testing on samples taken independently of the Contractor's quality control samples; at a frequency equal to or greater than 10% of the QC sample frequency; or

(F) By any combination of the above

The Engineer will periodically obtain quality assurance and verification mix samples for testing independently of the Contractor's quality control process. The Engineer will conduct assurance tests on both split QC samples taken by the Contractor and verification samples taken by the Department. These samples may be the regular quality control samples or a sample selected by the Engineer from any location in the process, or verification samples taken at random by the Department. The Engineer may select any or all split samples for assurance testing.

Density Quality Assurance

(A) By retesting randomly selected quality control test sections (either cores or nuclear) at a frequency equal to or greater than 5% of the frequency required of the Contractor.

(B) By periodically observing tests performed by the Contractor;

(C) By testing randomly selected comparison core samples taken adjacent to the Contractor's quality control core samples (8 inches center-to-center) at a frequency equal to or greater than 5% of the frequency required of the Contractor; and

(D) By conducting verification sampling and testing on test sections (either core or nuclear) independently of the Contractor's quality control test sections at a frequency equal to or greater than 10% of the QC sample frequency.

(E) By periodically directing the recalculation of random locations for the Quality Control core or nuclear density test sites. The original QC test locations may be tested by QA personnel and evaluated as verification tests.

Comparison and verification core samples will be taken in the presence of a DOT technician, and either delivered directly to the appropriate QA Laboratory by a DOT technician or placed in a sealed container and delivered to the Contractor's QC Laboratory for Quality Assurance personnel to obtain.

Results of quality assurance tests for plant mix and density will be provided to the Contractor within 3 working days after the sample has been obtained, except for verification TSR test results that will be provided within 7 calendar days.

Limits of Precision

Differences between the Contractor's and the Department's split sample test results will be considered acceptable if within the following limits of precision:

Mix Property		**Limits of Precision**
25.0mm sieve(Base Mix)		± 10.0%
19.0mm sieve(Base Mix)		± 10.0%
12.5mm sieve(Intermediate Mix)		± 6.0%
9.5mm sieve(Surface Mix)		± 5.0%
4.75mm sieve(Surface Mix)		± 5.0%
2.36mm sieve(All Mixes)		± 5.0%
0.075mm sieve(All Mixes)		± 2.0%
Asphalt Binder Content		± 0.5%
Maximum Specific Gravity(G_{mm})		± 0.020
Bulk Specific Gravity (G_{mb})		± 0.030
TSR		± 15.0%
QA retest of prepared QC Gyratory Compacted Volumetric Specimens		± 0.015
Retest of QC Core Sample		± 1.2% (% Compaction)
Comparison QA Core Sample		± 2.0% (% Compaction)
QA Verification Core Sample Nuclear Comparison of QC Test QA Nuclear Verification Test		± 2.0% (% Compaction) ± 2.0% (% Compaction) ± 2.0% (% Compaction)

The Engineer will immediately investigate the reason for differences if any of the following occur:

(A) QA test results of QC split sample does not meet above limits of precision, or

(B) QA test results of QC split sample does not meet the individual test control limits or the specification requirements, or

(C) QA verification sample test results exceed the allowable retesting tolerances.

If the potential for a pavement failure exist, the Engineer may suspend production, wholly or in part, in accordance with Article 108-7 while the investigation is in progress. The Engineer's investigation may include, but not be limited to the following:

(A) Joint testing of any remaining split samples,

(B) Review and observation of the QC technician's sampling and testing procedures,

(C) Evaluation and calibration of QC testing equipment,

(D) Comparison testing of other retained quality control samples, and/or additional density core samples.

If additional mix samples or core samples are necessary to resolve the difference, these samples will be taken as directed and tested jointly by the Contractor's quality control and Department's quality assurance personnel. If reasons for the difference cannot be determined, payment for the mix in question will be determined in accordance with Article 105-3. If the reason for the difference is determined to be an error or other discrepancy in the quality control test results, the applicable quality assurance test results or verification test results will be used to determine compliance with the applicable mix or density specification requirements.

The Engineer will periodically witness the sampling and testing being performed by the Contractor. If the Engineer observes that the sampling and quality control tests are not being performed in accordance with the applicable test procedures, the Engineer may stop production until corrective action is taken. The Engineer will promptly notify the Contractor of observed deficiencies, both verbally and in writing. The Engineer will document all witnessed samples and tests.

609-7 ACCEPTANCE

Final acceptance of the asphalt pavement will be made by the Department in accordance with the following:

Mix Acceptance

The Engineer will base final acceptance of the mix on the results of random testing made on split samples during the assurance process and validation of the Contractor's quality control process as outlined in Subarticle 609-5(C) and Article 609-6.

Density Acceptance

The Department will evaluate the asphalt pavement for density compliance after the asphalt mix has been placed and compacted using the Contractor's quality control test results, the Department's quality assurance test results, and by observation of the

Contractor's density quality control process as outlined in Subarticle 609-5(D), Article 609-6 and Article 610-13.

609-8 MEASUREMENT AND PAYMENT

Produce and construct all asphalt mixtures and pavements in accordance with these Specifications. There will be no direct payment for work covered by this Specification. Payment at the contract unit prices for the various asphalt items will be full compensation for all work covered by these specifications.

SECTION 610
ASPHALT CONCRETE PLANT MIX PAVEMENTS

610-1 DESCRIPTION

Perform the work covered by this section, including but not limited to the construction of one or more courses of asphalt mixture placed on a prepared surface in accordance with these Specifications and in reasonably close conformity with the lines, grades, thickness, and typical sections shown on the plans. This work includes producing, weighing, transporting, placing and compacting the plant mix; furnishing aggregate, asphalt binder, anti-strip additive, and all other materials for the plant mix; furnishing and applying tack coat as specified in Section 605; furnishing scales; maintaining the course until final acceptance of the project; making any repairs or corrections to the course that may become necessary; providing and conducting quality control as specified in Section 609; and surface testing of the completed pavement. The design requirements for the various mix types are given in Table 610-1 and Table 610-2 for Superpave mix types, Section 650 for OGAFC and Section 652 for PADC.

Provide and conduct the quality control and required testing for acceptance of the asphalt mixture in accordance with Section 609.

610-2 MATERIALS

See Division 10

Item	Section
Coarse aggregate	1012-1
Fine aggregate	1012-1
Mineral Filler	1012-1
Stone Screenings	1012-1
Reclaimed asphalt pavement	1012-1
Reclaimed asphalt shingles	1012-1
Natural sand	1012-1
Anti-strip additive (hydrated lime)	1012-1
Anti-strip additive (chemical)	1020-8
Asphalt Binder, Performance Grade	1020-2
Silicone	1020-4

610-3 COMPOSITION OF MIXTURES (MIX DESIGN AND JOB MIX FORMULA)

(A) Mix Design-General

Prepare the asphalt mix design utilizing a mixture of coarse and fine aggregate, asphalt binder, mineral filler, and other additives when required. Size, uniformly grade, and combine the several aggregate fractions in such proportions that the resulting mixture meets the grading and physical requirements of the Specifications for the specified mix type. Materials that will not produce a mixture within the design criteria required by the Specifications will be rejected, unless otherwise approved.

At least 10 days prior to start of asphalt mix production submit, in writing and in electronic form, the mix design and proposed job mix formula (JMF) targets for each required mix type and combination of aggregates to the Engineer for review and approval. Prepare the mix design using a Department certified mix design technician in an approved mix design laboratory. Perform the mix design in accordance with the Superpave mix design system as described in AASHTO R 35 Standard Practice for Designing Superpave HMA as modified by the Department. Perform, document and submit all mix designs in accordance with Department policies, procedures and computerized mix design programs. Submit the mix design and proposed job mix formula targets on approved forms and in the format required by the Department for the appropriate mix type. In addition, submit the mix design data in electronic format using the Department's latest mix design programs and procedures for the specified mix type. In addition, submit Superpave gyratory compactor printouts for all specimens compacted at Ndes during the mix design process.

For the final surface layer of the specified mix type, use a mix design with an aggregate blend gradation above the maximum density line on the 2.36 mm and larger sieves.

Reclaimed asphalt pavement (RAP) may constitute up to 50 percent of the total material used in recycled mixtures, except for mix Type S 12.5D, Type S 9.5D, and mixtures containing reclaimed asphalt shingle material (RAS). Reclaimed asphalt shingle (RAS) material may constitute up to 6 percent by weight of total mixture for any mix. When both RAP and RAS are used, do not use a combined percentage of RAS and RAP greater than 15% by weight of total mixture, unless otherwise approved. When the percent of binder contributed from RAS or a combination of RAS and RAP exceeds 20% of the total binder in the completed mix, the virgin binder PG grade shall be one grade below (both high and low temperature grade) the binder grade specified in Table 610-2 for the mix type.

For Type S 12.5D and Type S 9.5D mixes, the maximum percentage of reclaimed asphalt material is limited to 15% and shall be produced using virgin asphalt binder grade PG 76-22. For all other recycled mix types, when the percentage of RAP is 15% or less of the total mixture, the virgin binder PG grade shall be as specified in Table 610-2 for the specified mix type. When the percentage of RAP is greater than 15% but not more than 25% of the total mixture, the virgin binder PG grade must be

one grade below (both high and low temperature grade) the specified grade for the mix type detailed in Table 610-2. When the percentage of RAP is greater than 25% of the total mixture, the Engineer will establish and approve the asphalt binder grade.

Should a change in the source of RAP or RAS be made, a new mix design and/or job mix formula may be required in accordance with Article 1012-1. Samples of the completed recycled mixture may be taken by the Department on a random basis to determine the PG grading on the recovered asphalt binder in accordance with AASHTO M 320. If the grading is determined to be a value other than required for the specified mix type, the Engineer may require the Contractor to adjust the grade and/or percentage of additional asphalt binder, and/or the blend of reclaimed material to bring the grade to the specified value.

Prepare all proposed mix design data in accordance with Department policies and procedures including but not limited to, the following information:

(1) Source and percentage of each aggregate component to be used in the design aggregate blend gradation, including RAP and RAS.

(2) Percentage of asphalt binder in RAP and RAS.

(3) Gradation of each aggregates component, including RAP and RAS.

(4) The following aggregate properties: current bulk specific gravity (Gsb), current apparent specific gravity (Gsa) and absorption of the individual aggregate components to be used when tested in accordance with AASHTO T 84 and T 85, except report the effective bulk specific gravity (Gse) of RAP and RAS aggregate as determined by AASHTO T 209. Report coarse aggregate angularity, fine aggregate angularity, flat and elongated percentages, and sand equivalent for the total aggregate blend.

(5) Source(s), modification method, and percent of modifier by weight of asphalt binder, if modified.

(6) Supplier, source, grade, and equi-viscous mixing and compaction temperatures of the asphalt binder. Determine equi-viscous temperatures using the rotational viscometer in accordance with ASTM D 4402 corresponding to the following recommended viscosity ranges:

Range for mixing = 0.150 to 0.190 Pa-s

Range for compaction = 0.250 to 0.310 Pa-s

When PG 76-22 or other modified binders are used, base the temperatures on the documented supplier's recommendations.

(7) Brand name, manufacturer, shipping point, and percentage of anti-strip additive used in the mix design. Determine TSR data in accordance with AASHTO T 283 as modified by the Department.

(8) Target value for percent passing each standard sieve for the design aggregate gradation. Data will show the percent passing for all standard sieves listed in Table 610-1 for the specified mix type. Show the percentages in units of one percent of aggregate passing, except for the 0.075 mm (No. 200) sieve, show in units to one-tenth of one percent. Base percentages on the dry weight of aggregate determined in accordance with AASHTO T 11 and T 27.

(9) Volumetric properties of the compacted mixture calculated on the basis of the mixture's maximum specific gravity as determined by AASHTO T 209. The mixture shall be aged in accordance with AASHTO R 30 and the bulk specific gravity of specimens determined by AASHTO T 166, Method A, for each asphalt content tested. Determine and report properties in accordance with the requirements of AASHTO R 35 except as modified herein, and Department Mix Design Policies and Procedures.

(10) Graphical plots of percent asphalt binder by total weight of mix (Pb) versus the following properties at the design number of gyrations, Ndes, specified

(a) SGC bulk gravity, G_{mb} @ N_{des}

(b) % Gmm @ Nini

(c) Voids in total Mix (VTM)

(d) Voids Filled With Asphalt (VFA)

(e) Voids in Mineral Aggregate (VMA)

(f) % Compaction vs. Log of Gyrations

(11) Graphical plot of the design aggregate gradation (design blend) on FHWA 0.45 power chart showing the applicable control points, and maximum density line. Plot all standard sieves for the applicable mix type.

(12) Proposed target value of asphalt binder content by weight of total mix and specification design properties at that percentage.

(13) TSR test data in accordance with AASHTO T 283(Modified)

In addition to the required mix design submittal forms, the Contractor shall deliver six (6) Superpave Gyratory Compactor specimens to the Department's Central Asphalt Laboratory for the following surface mix types: SF 9.5A, S 9.5B, S 9.5C, S 9.5D, S 12.5C and S 12.5D. The Contractor will prepare these specimens using lab produced mix in accordance with AASHTO T 312 (Modified). These specimens shall be compacted to a height of 75mm and to a void content (VTM) of 4.0% +/- 0.5%. These specimens will be tested for rutting susceptibility using the Asphalt Pavement Analyzer in the Materials and Test Central facility or other approved facility.

In addition, when requested by the Engineer, submit to the Department's Materials & Tests Asphalt Design Laboratory, representative samples of each mix component, including RAP, RAS, mineral filler, asphalt binder, chemical anti-strip additive and hydrated lime as noted below. Provide the samples at least 20 days prior to the anticipated beginning placement of mixture.

250 lb. of each coarse aggregate
150 lb. of each intermediate and fine aggregate
150 lb. RAP and / or RAS
1 gal. of mineral filler and/or baghouse fines
2 gal. of asphalt binder
1 gal. of hydrated lime

When the submitted aggregate samples are combined according to the Contractor's proposed blend percentages, the combined gradation shall be within the gradation band defined by the design criteria specified in Table 610-1 for each sieve or the samples will not be considered representative and new samples may be required.

(B) Mix Design Criteria

Design and produce asphalt concrete mixtures that conform to the gradation requirements and design criteria in Table 610-1 and Table 610-2 for the mix type specified. The mix type designates the nominal maximum aggregate size and the design traffic level.

Surface mix designs will be tested by the Department for rutting susceptibility. Rut depth requirements for each surface mix type and traffic level are specified in Table 610-2. Mix designs that fail to meet these requirements will be considered unacceptable and must be redesigned by the Contractor such that rut depths are acceptable.

Table 610-1 provides gradation control points to be adhered to in the development of the design aggregate structure for each mix type. Aggregate gradations shall be equal to or pass between the control points, unless approved in writing. Table 610-2 provides the mix design criteria for the various mix types.

Use an anti-strip additive in all Superpave asphalt mixes. It may be hydrated lime or a chemical additive or a combination of both as needed to meet the retained strength requirements as specified in TABLE 610-2. When a chemical additive is used, add at a rate of not less than 0.25% by weight of binder in the mix. When hydrated lime is used, add at a rate of not less than 1.0 % by weight of the total dry aggregate.

(C) Job Mix Formula

Establish the job mix formula (JMF) gradation target values within the design criteria specified for the particular type of asphalt mixture to be produced. Establish the JMF asphalt binder content at the percentage that will produce voids in total mix (VTM) at the midpoint of the specification design range for VTM, unless otherwise approved. The formula for each mixture will establish the following: blend percentage of each aggregate fraction, the percentage of reclaimed aggregate, if applicable, a single percentage of combined aggregate passing each required sieve size, the total

percentage and grade of asphalt binder required for the mixture (by weight of total mixture), the percentage and grade of asphalt binder to be added to the mixture (for recycled mixtures), the percentage of chemical anti-strip additive to be added to the asphalt binder or percentage of hydrated lime to be added to the aggregate, the temperature at that the mixture is to be discharged from the plant, the required field density, and other volumetric properties.

The mixing temperature at the asphalt plant will be established on the job mix formula. For mix types listed in Table 610-2, the mixing temperature will be established between 265°F and 350°F or as approved. Unless otherwise requested, the JMF temperature will be established as follows:

Mixes with binder grade	PG 64-22	300°F
	PG 70-22	315°F
	PG 76-22	335°F

Have on hand at the asphalt plant the approved mix design and job mix formula issued by the Department, prior to beginning the work.

The job mix formula for each mixture will remain in effect until modified in writing, provided the results of QMS tests performed in accordance with Section 609 on material currently being produced conform with specification requirements. When a change in sources of aggregate materials is to be made, a new mix design and job mix formula will be required before the new mixture is produced, unless otherwise approved. When a change in sources of RAP or RAS material is to be made, a new mix design and/or job mix formula may be required in accordance with Article 1012-1. When unsatisfactory results or other conditions make it necessary, the Engineer may revoke the existing job mix formula or establish a new job mix formula.

TABLE 610-1
SUPERPAVE AGGREGATE GRADATION DESIGN CRITERIA

Standard	Percent Passing Criteria (Control Points)											
Sieves	Mix Type (Nominal Maximum Aggregate Size)											
	4.75 mm (a)		9.5 mm (c)		12.5 mm (c)		19.0 mm		25.0 mm		37.5 mm	
(mm)	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
50.0											100.0	
37.5									100.0		90.0	100.0
25.0							100.0		90.0	100.0		90.0
19.0					100.0		90.0	100.0		90.0		
12.5			100.0		90.0	100.0		90.0				
9.5	100.0		90.0	100.0		90.0						
4.75	90.0	100.0		90.0								
2.36	65.0	90.0	32.0(b)	67.0(b)	28.0	58.0	23.0	49.0	19.0	45.0	15.0	41.0
1.18												
0.600												
0.300												
0.150												
0.075	4.0	8.0	4.0	8.0	4.0	8.0	3.0	8.0	3.0	7.0	3.0	6.0

(a) For Type S 4.75A, a minimum of 50% of the aggregate components shall be material manufactured from the crushing of stone.

(b) For Type SF 9.5A, the percent passing the 2.36mm sieve shall be a minimum of 60% and a maximum of 70%.

(c) For the final surface layer of the specified mix type, use a mix design with an aggregate blend gradation above the maximum density line on the 2.36 mm and larger sieves.

TABLE 610-2
SUPERPAVE MIX DESIGN CRITERIA

	Design	Binder	Compaction Levels			Volumetric Properties (c)			
Mix Type	ESALs millions	PG Grade	No. Gyrations @		Max. Rut Depth	VMA	VTM	VFA	%Gmm
(e)	(a)	(b)	N_{ini}	N_{des}	(mm)	% Min.	%	Min. - Max.	@ N_{ini}
S-4.75A	<0.3	64 -22	6	50	-------	20.0	7.0-15.0		-------
SF-9.5A	<0.3	64 -22	6	50	11.5	16.0	3.0 - 5.0	70 - 80	≤ 91.5
S-9.5B	0.3 - 3	64 -22	7	75	9.5	15.0	3.0 - 5.0	65 - 80	≤ 90.5
S-9.5C	3 - 30	70 -22	8	100	6.5	15.0	3.0 - 5.0	65 - 76	≤ 90.0
S 9.5D	> 30	76 -22	9	125	4.5	15.0	3.0 - 5.0	65 - 76	≤ 90.0
S-12.5C	3 - 30	70 -22	8	100	6.5	14.0	3.0 - 5.0	65 - 75	≤ 90.0
S-12.5D	> 30	76 -22	9	125	4.5	14.0	3.0 - 5.0	65 - 75	≤ 90.0
I-19.0B	< 3	64 -22	7	75	---------	13.0	3.0 - 5.0	65 - 78	≤90.5
I-19.0C	3 - 30	64 -22	8	100	---------	13.0	3.0 - 5.0	65 - 75	≤ 90.0
I-19.0D	> 30	70 -22	9	125	---------	13.0	3.0 - 5.0	65 - 75	≤ 90.0
B-25.0B	< 3	64 -22	7	75	---------	12.0	3.0 - 5.0	65 - 78	≤ 90.5
B-25.0C	> 3	64 -22	8	100	---------	12.0	3.0 - 5.0	65 - 75	≤ 90.0
B-37.5C	> 3	64 -22	8	100	---------	11.0	3.0 - 5.0	63 - 75	≤ 90.0
	Design Parameter					**Design Criteria**			
All Mix Types	1. Dust to Binder Ratio ($P_{0.075}$ / P_{be})					0.6 - 1.4			
	2. Retained Tensile Strength (TSR)(AASHTO T 283 Modified)					85 % Min. **(d)**			

Notes (a) Based on 20 year design traffic.

(b) When Recycled Mixes are used, select the binder grade to be added in accordance with Subarticle 610-3(A).

(c) Volumetric Properties based on specimens compacted to N_{des} as modified by the Department.

(d) AASHTO T 283 Modified (No Freeze-Thaw cycle required). TSR for Type S 4.75A, Type B 25.0 and Type B 37.5 mixes is 80% minimum.

(e) Mix Design Criteria for Type S 4.75A may be modified subject to the approval of the Engineer

610-4 WEATHER, TEMPERATURE, AND SEASONAL LIMITATIONS FOR PRODUCING AND PLACING ASPHALT MIXTURES

Do not produce or place asphalt mixtures during rainy weather, when the subgrade or base course is frozen, or when the moisture on the surface to be paved would prevent proper bond. Do not place asphalt material when the air temperature, measured in the shade away from artificial heat at the location of the paving operation and the road surface temperature in the shade is less than the temperatures shown in Table 610-3.

Do not place surface course material that is to be the final layer of pavement between December 15 and March 16 of the next year if it is 1" or greater in thickness or between November 15 and April 1 of the next year if it is less than 1" in thickness, unless otherwise approved. Do not place open-graded asphalt friction course between October 31 and April 1 of the next year, unless otherwise approved.

As an exception to the above, when in any day's operations the placement of a layer of asphalt base course material or intermediate material 2" or greater in thickness has started, it may continue until the temperature drops to 32°F.

Do not place plant mix base course or intermediate course that will not be covered with surface course during the same calendar year or within 15 days of placement if the plant mix is placed in January or February. Failure by the Contractor to cover the plant mix as required above will result in the Engineer notifying the Contractor in writing to cover the plant mix with a sand seal. Apply the sand seal in accordance with the requirements of Section 660, except that Articles 660-3, 660-11, and 660-12 will not apply. Perform this work at no cost to the Department. In the event the Contractor fails to apply the sand seal within 72 hours of receipt of such notice, the Engineer may proceed to have such work performed with Department forces and equipment. The cost of such work performed by Department forces will be deducted from monies due or to become due to the Contractor.

TABLE 610-3
ASPHALT PLACEMENT- MINIMUM TEMPERATURE REQUIREMENTS

Asphalt Concrete Mix Type	Minimum Air Temperature	Minimum Road Surface Temperature
ACBC, Type B 25.0B, C, B 37.5C	35°F	35°F
ACIC, Type I 19.0B, C, D	35°F	35°F
ACSC, Type S 9.5C, D, S 12.5C, D	50°F	50°F
ACSC, Type S 4.75A, SF 9.5A, S 9.5B	40°F	50°F

610-5 ASPHALT MIXTURE PRODUCTION

(A) General

Utilize plants that are either of the batch mixing, continuous mixing, or drum mixing type, and so designed, equipped, and operated that the weighing, proportioning, and mixing of the materials will result in a uniform and satisfactory asphalt mixture meeting the requirements of these Specifications. All plants shall conform to requirements of Subarticle 610-5(B) for the preparation of asphalt mixtures. In addition, batch mixing plants shall conform to the requirements of Subarticle 610-5(C), continuous mixing plants shall conform to the requirements of Subarticle 610-5(D), and drum mixing plants shall conform to the requirements of 610-5(E).

Prior to production of the mix, stockpile aggregates for a sufficient period of time to facilitate the drainage of free moisture. Keep the different aggregate sizes separated

until they have been delivered to the cold feeders. Keep the separate stockpiles readily accessible for sampling.

When mineral filler is required in the mix, feed or weigh-in separately from the other aggregates.

Introduce the asphalt binder and other additives, when required, into the mixture at the amounts and percentages specified by the job mix formula. No working tolerance will be allowed. Introduce the dried and heated aggregates, and mineral filler, when required, in amounts and at temperatures such that the mixture produced is within the production control limits of Subarticle 609-5(C)(4). Provide a positive means of controlling mixing time so as to obtain complete and uniform coating of the aggregate particles and thorough distribution of the asphalt binder throughout the aggregate.

Produce the mixture at the asphalt plant within ±15°F of the temperature established on the JMF. Assure the temperature of the mix immediately prior to discharge from the hauling vehicle is within +15°F to -25°F of the JMF temperature.

All asphalt plants shall be certified by the Department as meeting the requirements of these Specifications. Certification is effective from the date of issuance and is non-expiring subject to continued compliance. The Department will check the plant on an annual basis or as deemed necessary by the Engineer. Any plant that is relocated, modified, or changes ownership shall be recertified prior to use.

Any completely automatically controlled asphalt plant that, due to the basic design of the plant, does not meet all the requirements of these Specifications for conventional batch mixing, continuous mixing, or drum mixing may be utilized on a project by project basis provided a uniformly consistent mix meeting all mix requirements can be produced and the plant has been approved in writing.

(B) Requirements for All Plants

(1) Equipment for Preparation of Asphalt Binder

Equip tanks for the supplying of asphalt binder to the plant to uniformly heat and hold the material at the required temperature prior to introduction into the mixer unit. Provide a circulating system for asphalt materials, that is capable of the proper mixing of additives. Provide a system with adequate pump or pumps to charge the mixing unit and unload asphalt material simultaneously. Include provisions for measuring and sampling plant supply tanks.

(2) Anti-Strip Additive Equipment

When chemical anti-strip additive is to be added to the asphalt binder at the asphalt plant in lieu of at the terminal, equip the plant with an in-line blending system capable of metering the additive within plus or minus 10 percent of the amount specified. Provide a thermostatically controlled heating system capable of heating and maintaining the additive tanks, contents and distribution system at the additive supplier's recommended temperature for the additive being used. Interlock the additive metering system with the

asphalt binder control equipment in such a manner as to automatically vary the additive feed rate to maintain the required proportions. Provide a system that will automatically indicate in the plant control room the amount or rate of flow, when flow is occurring, and when flow is obstructed or stops. Inject the additive into the asphalt binder feed line prior to introduction into the aggregate. Equip the feed line with an in-line blending device capable of thoroughly mixing the additive with the asphalt binder prior to mixing with the aggregate. Provide a metering system capable of being calibrated, checked, and monitored for accuracy and amount of additive used.

Equip the system with an in-line totalizing flow meter capable of measuring the actual quantity in gallons of anti-strip additive that is injected into the asphalt binder being introduced into the aggregate. Provide a system that is capable of being easily read but not capable of being reset. Install the totalizer meter in the anti-strip feedline beyond the calibration bypass and as close to the actual point of additive introduction into the feedline as practical.

When hydrated lime anti-strip additive is used, provide a separate bin or tank and feeder system to store and proportion the lime into the aggregate in either dry or slurry form. Mix the lime and aggregate by pugmill or other approved means to achieve a uniform lime coating of the aggregate prior to entering the drier. When the lime is added in dry form, the aggregate shall contain at least 3 percent free moisture. The stockpiling of lime treated aggregate will not be permitted. Control the lime feeder system by a proportioning device that is accurate to within ±10 percent of the specified amount. Provide a proportioning device with a convenient and accurate means of calibration and that is interlocked with the aggregate feed or weigh system so as to maintain the correct proportion. Provide a flow indicator or sensor that is interlocked with the plant controls such that production of the mixture will be interrupted if there is a stoppage or reduction of the lime feed.

(3) Aggregate Cold Feed Equipment

Utilize cold bins and a feeder system to proportion the aggregates and feed them to the dryer. Use separate cold bins for each size aggregate and each natural sand being used to provide a uniform and continuous flow. Provide separate dry storage when mineral filler is required. Equip cold aggregate bins with feeder units having interlocking controls capable of maintaining a constant ratio between the relative quantities of each size aggregate at varying plant production rates.

Provide cold feeders that are capable of being easily and accurately calibrated to ensure full control of the mix gradation.

(4) Dryer

Use a plant with a dryer or dryers that continuously agitate the aggregate during the heating and drying process.

(5) Control Unit for Asphalt Binder

Provide satisfactory means, either by weighing or metering to introduce the proper amount of asphalt binder into the mix.

(6) Thermometric Equipment

(a) Asphalt Binder Thermometric Equipment

Provide a thermometric device of adequate temperature range fixed in the asphalt binder feed line.

(b) Dryer Thermometric Equipment:

Equip the dryer with an automatic burner control device that uses an approved thermometric instrument located in the discharge chute to actuate the automatic controls.

(7) Pollution Control Equipment

Equip all plants with such pollution control equipment as is necessary to meet all applicable local, State, and Federal pollution requirements. Register and certify all plants by applicable environmental regulatory agencies prior to being certified by the Department.

(8) Safety Requirements

Provide adequate safety devices at all points where accessibility to plant operations is required. Provide accessibility to the top of truck bodies by a platform or other suitable device to enable Quality Control and Quality Assurance personnel to obtain samples and mixture temperature data. Thoroughly guard and protect all gears, pulleys, chains, sprockets, and other dangerous moving parts. Provide ample and unobstructed space on the mixing platform. Maintain a clear and unobstructed passage at all times in and around the truck loading area. Keep all work areas free from asphalt drippings.

(9) Production Consistency

Any asphalt plant that cannot consistently produce a high quality mix meeting the requirements of these Specifications will be considered in non-compliance with these Specifications and may have its certification revoked.

Upon a malfunction of required automatic equipment on a batch mixing plant, the plant may continue to operate manually for the following 2 consecutive working days, provided acceptable mixture is being produced.

When a malfunction of required automatic equipment on a drum mixer or continuous plant occurs, manual operation of the plant will not be allowed except that if, in the opinion of the Engineer, an emergency traffic condition exists, the plant may be allowed to operate manually until the unsafe traffic condition is corrected. All mix produced by manual operation will be subject to the requirements of Section 609.

(C) Requirements for Batch Mixing Plants

(1) Plant Scales and/or Weighing Devices

Provide and keep scales accurate to 0.5 percent at anticipated scale settings that may be required.

Scales will be inspected and tested as described in the latest edition of the Department's *HMA/QMS Manual* or as the Engineer may deem necessary to assure their continued accuracy.

Provide not less than ten 50-pound weights for testing the plant scales.

(2) Screens

Provide plant screens that are capable of adequately screening aggregates to the specified sizes necessary to consistently produce a mixture meeting the requirements of the job mix formula. Provide screens for removing all oversize materials.

(3) Hot Bins

Include hot storage bins of sufficient capacity and number to supply the mixer with uniform material. Equip each compartment with adequate and convenient devices to provide for sampling. Provide each compartment with an overflow pipe of such sizes and at such locations as to prevent any backing up of the material into other bins or interference with the operations of screens. Provide gates that close tightly so that no material is allowed to leak into the weigh hopper.

(4) Weigh Box or Hopper

Use equipment that includes a means for accurately weighing each size of aggregate in a weigh box or hopper suspended on scales and of ample size to hold a full batch without running over. Provide a gate that closes tightly so that no material is allowed to leak into the mixer while a batch is being weighed.

(5) Asphalt Binder Controls

Use equipment to measure the asphalt binder that is capable of an accuracy of plus or minus 0.5 percent by weight of the amount of asphalt binder required. Locate the flow indicator, whether scale or metering device is used, in full view of the operator.

Provide an asphalt binder bucket of the non-tilting type with a removable top.

Provide gates that close tightly such that no material is allowed to leak into the weigh hopper. Adequately heat the asphalt binder bucket, its discharge valve or valves, and distribution bar. Ensure heating connections are so constructed that they will not interfere with the efficient operation of the asphalt binder scales. Provide an asphalt binder bucket with a capacity of at least 15 percent in excess of the weight of asphalt binder required in any batch. Locate an

adequately heated, quick-acting, non-drip, charging valve near the asphalt binder bucket.

When a metering device is substituted for an asphalt binder bucket, use a flow indicator with a capacity of at least 15 percent in excess of the quantity of asphalt binder used in a batch. Provide a valve and outlet for checking the meter in the section of asphalt feed line between the charging valve and distribution bar.

Provide a system capable of discharging all of the asphalt binder required for one batch in not more than 15 seconds after the flow has started. Make the size and spacing of the distribution bar openings capable of providing a uniform application of asphalt binder across the full length of the mixer.

(6) Mixer

Provide batch mixer of an approved type that is capable of producing a uniform mixture. If not enclosed, equip the mixer box with a dust hood to prevent loss of dust. Provide a batch mixer with a rated capacity of not less than 3,000 pounds.

Maintain the clearance of blades from all fixed and moving parts such as to insure complete coating and mixing of aggregates and asphalt binder.

(7) Control of Proportioning and Mixing

Utilize plants with fully automated controls for proportioning and mixing. Equip the mixer with an accurate interlocking timing device to control the operations of a complete mixing cycle.

Use a timing device capable of being set at intervals of 5 seconds or less throughout a total cycle.

Mixing time will be established by the Engineer. Provide means by lock, cover, or other methods to prevent unauthorized changes in mixing time.

(D) Requirements for Continuous Mixing Plants

(1) General

Utilize continuous mixing plants that have fully automated proportioning and mixing controls and a rated capacity of at least 90 tons per hour.

(2) Aggregate Proportioning

Equip the plant with a feeder system capable of being accurately calibrated to uniformly produce the specified mixture.

Include means for accurately proportioning each size of aggregate to consistently meet the requirements of the job mix formula.

(3) Screens

Provide plant screens that are capable of adequately screening aggregates to the specified sizes necessary to consistently produce a mixture meeting the

requirements of the job mix formula. Use screens that are capable of removing all oversize materials.

(4) Hot Bins

Provide hot storage bins of sufficient capacity and number to supply the mixer with uniform material. Equip each compartment with adequate and convenient devices to allow for sampling. Equip each compartment with an overflow pipe of such sizes and at such locations as to prevent any backing up of material into other bins or interference with the operations of screens. Provide adjustable gates such that the rate of flow can be controlled.

(5) Synchronization of Aggregate Feed and Asphalt Binder Feed

Provide satisfactory means to afford positive interlocking control between the flow of aggregate from the bins and the flow of asphalt binder from the meter or other proportioning device. Accomplish this control by interlocking mechanical means or by other positive methods satisfactory to the Engineer.

(6) Mixer

Provide a continuous mixer of an approved type, adequately heated and capable of producing a uniform mixture. Equip the mixer with a discharge hopper with dump gates that will permit rapid and complete discharge of the mixture. Provide paddles that are adjustable for angular position on the shafts and reversible to retard the flow of the mix. Provide the manufacturer's plate giving the net volumetric contents of the mixer at several heights inscribed on a permanent gauge. Provide charts showing the rate of feed per revolution and per interval of time at the plant operating speed.

(E) Requirements for Drum Mix Plants

(1) Aggregate Feed Equipment

Equip each cold feeder with an automatic device that activates a warning alarm and/or flasher light when any bin becomes empty or when aggregate flow becomes restricted. Interlock the automatic device with the plant control system so as to automatically stop production if normal aggregate flow is not resumed within 60 seconds.

(2) Scalping Screen

Provide a vibratory screening system capable of removing all oversize materials for the particular mix being produced prior to entry of the aggregate into the dryer-drum mixer. Locate the screening system in the aggregate flow prior to the material passing over the aggregate weighing system.

(3) Weight Measurement of Aggregate

Provide a system that ensures positive weight measurement of the combined cold aggregate feed rate by the use of belt scales or other approved devices. Provide means to allow correction for variations in the moisture content of the cold aggregate. Provide a continuous readout or other means that can be

monitored in the plant control room and that indicates the aggregate dry-weight equivalent feed rate. Interlock the aggregate weighing system and binder flow to automatically maintain the required proportions. Provide a weighing system capable of being easily and accurately calibrated.

(4) Dryer-Drum Mixer Unit

Provide a drum mixer that is specifically designed and constructed for the process and capable of producing a uniform mixture. Control heating to prevent damage to the aggregate and asphalt binder. Provide a dryer-drum mixer with a rated capacity of at least 90 tons per hour when producing a finished mixture at 300°F with removal of 5 percent moisture.

(5) Asphalt Binder Controls

Provide a metering system capable of introducing the required amount of asphalt binder in the mix, including a means of correcting the delivered asphalt binder flow rate for temperature and specific gravity variations. Connect the flow meter to the asphalt binder supply so as to measure and display only the asphalt binder being fed to the mixer unit. Position the meter readout for convenient observation by the plant operator.

Provide means for checking the rate of flow of asphalt binder into the mixing unit. Assure the rate of flow is accurate to 0.5 percent by weight of the amount of asphalt binder required.

(6) Synchronization of Aggregate Feed and Asphalt Binder Feed

Interlock the asphalt binder feed control with the total aggregate weight measurement device in such a manner as to automatically vary the asphalt binder feed rate as necessary to maintain required proportions. Interlock the controls in a manner that will automatically stop all feed components if either the aggregate or asphalt flow stops.

(7) Asphalt Mixture Storage Facilities

Provide hot mix surge storage facilities in accordance with Article 610-6 that are adequate to minimize production interruptions during operation and ensure the mixture meets the requirements of the job mix formula when discharged from the storage bin.

610-6 HOT MIX STORAGE SYSTEMS

When a storage system is used, provide a system capable of conveying the mix from the plant to the storage bin and storing the mix without a loss in temperature, segregation or oxidation of the mix. Limit storage time to the ability of the storage system to maintain the mix with in the specification requirements. Material may be stored in storage bins without an approved heating system for no more than 24 hours.

Provide a continuous type or skip bucket type conveyor system. Enclose continuous type conveyors so that the mix temperature is maintained within specification requirements. Provide a system designed in such manner as to prevent segregation of the mix during

discharge from the conveyor into the bins and equipped with discharge gates that will not cause segregation of the mix while loading the mix into trucks.

610-7 HAULING OF ASPHALT MIXTURE

Transport the mixture from the mixing plant to the point of use in vehicles that have tight, clean, smooth beds approved by the Department, that have been sprayed with an approved release agent material, to prevent the mixture from adhering to the beds. Remove excess release agent prior to loading. Cover each load of mixture with a canvas or other suitable material. Use covers that are so constructed and secured as to prevent the entrance of moisture and the rapid loss of temperature. Provide a 3/8 inch diameter hole on each side of the vehicle body near the center of the body and 6 inches above the bed of the vehicle for the purpose of inserting a thermometer.

Assure temperature of the mixture immediately prior to discharge from the hauling vehicle is within a tolerance of plus 15°F to minus 25°F of the specified job mix formula temperature.

610-8 SPREADING AND FINISHING

Apply tack coat in accordance with the requirements of Section 605.

Mixtures produced simultaneously from different plant sources can not be intermingled by hauling to the same paver on the roadway unless the mixtures are being produced from the same material sources and same job mix formula.

Utilize a self-contained, power propelled paver capable of spreading and finishing the asphalt mixture to the required grades, cross sections, thicknesses, and widths shown on the plans and typical sections and to uniform density and texture. Equip and operate the paver with a fully activated screed plate that is designed to be preheated for the full length whenever necessary. Provide a screed of adequate length to spread and finish the full uniform width travel lane being placed, unless otherwise permitted. Do not use strike off devices, either mechanically or manually operated, in spreading and finishing mixture placed in the uniform width travel lane.

Utilize a the paver with a receiving hopper and an automatically controlled distribution system that is capable of uniformly maintaining a proper head of material in front of the full length of the screed, including screed extensions. Equip the screed unit with a sliding shoe attachment that will form a slope on the edge of the mat to prevent edge raveling when the mixture is compacted.

Place a string line for the first lane of each layer of mixture placed to provide alignment control for the paver, except that a string line will not be required when the first layer is placed adjacent to a curb section.

Operate pavers at forward speeds consistent with plant production, material delivery, and satisfactory laying of the mixture so as to ensure a uniform and continuous laydown operation. Coordinate and adjust the paving operation and loading operation so as to maintain an adequate amount of asphalt mixture in the paver hopper between truck exchanges. Do not allow the paver hopper to become empty between loads. Take necessary precautions during production, loading of trucks, transportation, truck exchanges with paver,

folding of the paver hopper wings, and conveying material in front of the screed to prevent segregation of the asphalt mixtures. Should unevenness of texture, tearing, segregation, or shoving occur during the paving operation due to unsatisfactory methods or equipment, immediately take such action as may be necessary to correct such unsatisfactory work. Excessively throwing back material will not be permitted.

Use pavers equipped with an electronic screed control that will automatically control the longitudinal profile and cross slope of the pavement. Control the longitudinal profile through the use of either a mobile grade reference(s), including mechanical, sonic and laser grade sensing and averaging devices, an erected string line(s) when specified, joint matching shoe(s), slope control devices or the approved methods or combination of methods. Unless otherwise specified, use a mobile grade reference system capable of averaging the existing grade or pavement profile over a minimum 30 foot distance or by non-contacting laser or sonar type ski with at least four referencing stations mounted on the paver at a minimum length of 24 feet. Establish the position of the reference system such that the average profile grade is established at the approximate midpoint of the system. The transverse cross-slope shall be controlled as directed by the Engineer.

Use an erected fixed stringline for both and longitudinal profile and cross slope control when required by the contract. When an erected fixed string line is required, furnish and erect the necessary guide line for the equipment. Support the stringline with grade stakes placed at maximum intervals of 25 feet for the finished pavement grade.

Use the 30 foot minimum length mobile grade reference system or the non-contacting laser or sonar type ski to control the longitudinal profile when placing the initial lanes and all adjacent lanes of all layers, including resurfacing and asphalt in-lays, unless other specified or approved. A joint matching device (short 6 inch shoes) may be used only when approved.

Utilize the automatic slope control system unless otherwise approved. The Engineer may waive the use of automatic slope controls in areas where the existing surface (subgrade, base, asphalt layer, etc.) exhibits the desired cross slope of the final surface. The Engineer may also waive the use of automatic slope controls in areas where the use of such equipment is impractical due to irregular shape or cross section (such as resurfacing). When the use of the automatic slope controls is waived, the Engineer may require the use of mobile grade references on either or both sides of the paver. Manual screed operation will be permitted in the construction of irregularly shaped and minor areas, subject to approval. Waiver of the use of automatic screed controls does not relieve the Contractor of achieving plan profile grades and cross-slopes.

In the case of malfunction of the automatic screed control equipment, the paver may be manually operated for the remainder of the workday provided this method of operation produces acceptable results. Do not resume work thereafter until the automatic system is functional.

The Engineer will waive the requirement for use of pavers for spreading and finishing where irregularities or obstacles make their use impractical. Spread, rake, and lute the mixture by hand methods or other approved methods in these areas.

Operate the paver as continuously as possible. Pave intersections, auxiliary lanes, and other irregular areas after the main line roadway has been paved, unless otherwise approved.

Repair any damage caused by hauling equipment across structures at no additional cost to the Department.

Use a Material Transfer Vehicle (MTV) when placing all asphalt concrete plant mix pavements, including open-graded asphalt friction course, that require the use of asphalt binder grade PG 76-22, unless otherwise approved. Utilize the MTV when placing all full width travel lanes, including shoulders, collector lanes, ramps, and loops that require PG 76-22.

Provide an MTV that receives mixture from the hauling equipment and independently delivers the mixture from the hauling equipment to the paving equipment. Provide an MTV capable of transferring the material from the haul vehicle to the paver hopper at a uniform and continuous rate to allow the continuous movement of the paver. Install a paver hopper insert with a minimum capacity of 7 tons in the hopper of conventional paving equipment when utilizing a MTV. Perform remixing of the material prior to discharge into the paver conveyor system by utilizing either a MTV with a remixing system contained within a minimum 7 ton capacity storage bin or a dual pugmill system with two full length transversely mounted paddle mixers located in the paver hopper insert.

Use an MTV that provides to the paver a homogeneous, non-segregated mixture that is of uniform temperature such that there is no more than 20°F difference between the highest and lowest temperatures when measured transversely across the width of the mat in a straight line at a distance of one foot to three feet from the screed while the paver is operating. Obtain the temperature measurements approximately one foot from each edge and at least once in the middle of the mat.

Empty the MTV when crossing a bridge and move across without any other Contractor vehicles or equipment being on the bridge. Move the MTV across a bridge in a travel lane and not on the shoulder. While crossing a bridge move the MTV at a speed no greater than five miles per hour without any abrupt acceleration or deceleration.

In the event the MTV malfunctions during paving operations, immediately discontinue plant operations and do not resume operations until the MTV malfunctions have been remedied, unless otherwise directed due to safety concerns. The Contractor may continue placement of the mix until any additional mix in transit has been placed, provided satisfactory results are achieved. This procedure in no way alleviates the Contractor from meeting contract requirements.

610-9 COMPACTION

Immediately after the asphalt mixture has been spread, struck off, and surface and edge irregularities adjusted, thoroughly and uniformly compact the pavement. Compact the mix to the required degree of compaction for the type of mixture being placed.

Provide sufficient number and weight of rollers, except as noted, to compact the mixture to the required density while it is still in a workable condition. Obtain approval of equipment used in compaction from the Engineer prior to use. Where uniform density is not being obtained throughout the depth of the layer of material being tested, change the type

and/or weight of the compaction equipment as necessary to achieve uniform density even though such equipment has been previously approved.

Compact all final wearing surfaces, except open-graded asphalt friction course, using a minimum of 2 steel wheel tandem rollers, unless otherwise approved. Pneumatic-tired rollers with 2 tandem axles and smooth tread tires may be used for intermediate rolling.

Limit rolling for open-graded asphalt friction course to one coverage with a tandem steel wheel roller weighing a maximum of 10 tons, with additional rolling limited to one coverage with the roller where necessary to improve the riding surface.

Steel wheel tandem vibratory rollers that have been specifically designed for the compaction of asphalt pavements may be used on all layers 1 inch or greater in thickness during the breakdown and intermediate rolling phase. Do not operate vibratory rollers in the vibratory mode during the finish rolling phase on any mix type or pavement course, open-graded asphalt friction course, or on permeable asphalt drainage course.

When vibratory rollers are used, use rollers that have variable amplitude and frequency capabilities and that are designed specifically for asphalt pavement compaction. Provide rollers equipped with controls that automatically disengage the vibration mechanism before the roller stops when being used in the vibratory mode.

The Engineer may prohibit or restrict the use of vibratory rollers where damage to the pavement being placed, the underlying pavement structure, drainage structures, utilities, or other facilities is likely to occur or is evident.

Do not use rolling equipment that results in excessive crushing of the aggregate or excessive displacement of the mixture.

In areas inaccessible to standard rolling equipment, thoroughly compact the mixture by the use of hand tampers, hand operated mechanical tampers, small rollers, or other approved methods.

Use rollers that are in good condition and capable of being reversed without backlash to compact the mixture. Operate rollers with the drive wheels nearest the paver and at uniform speeds slow enough to avoid displacement of the mixture. Equip steel wheel rollers with wetting devices that will prevent the mixture from sticking to the roller wheels.

Begin compaction of the material immediately after the material is spread and shaped to the required width and depth. Carry out compaction in such a manner as to obtain uniform density over the entire section. Perform compaction rolling at the maximum temperature at that the mix will support the rollers without moving horizontally. Complete the compaction (including both intermediate rolling) prior to the mixture cooling below a workable temperature. Perform finish rolling to remove roller marks resulting from the compaction rolling operations.

610-10 DENSITY REQUIREMENTS

TABLE 610-4
MINIMUM DENSITY REQUIREMENTS

MIX TYPE	MINIMUM % of G_{mm}
SUPERPAVE MIXES	**(Maximum Specific Gravity)**
S 4.75A	85.0[(a,b)]
SF 9.5A	90.0
S 9.5X, S 12.5X, I 19.0X, B 25.0X, B 37.5X	92.0

(a) All S 4.75A pavement will be accepted for density in accordance with Article 105-3

(b) Compaction to the above specified density will be required when the S 4.75 A mix is applied at a rate of 100 lbs/sy or greater

Compact the asphalt plant mix to at least the minimum percentage of the maximum specific gravity listed in Table 610-4, except as noted below. Perform density sampling and testing on all pavements listed below unless otherwise approved.

(A) Full width travel lane pavements, including normal travel lanes, turn lanes, collector lanes, ramps and loops, and temporary pavements,

(B) Pavement widening 4.0 feet or greater,

(C) Uniform width paved shoulders 2.0 feet or greater,

(D) and wedging as outlined in the HMA/QMS Manual

Compact base and intermediate mix types (surface mixes not included) utilized for pavement widening of less than 4.0 feet and all mix types used in tapers, irregular areas and intersections (excluding full width travel lanes of uniform thickness), using equipment and procedures appropriate for the pavement area width and/or shape. Compaction with equipment other than conventional steel drum rollers may be necessary to achieve adequate compaction. Occasional density sampling and testing to evaluate the compaction process may be required. Densities lower than that specified in Table 610-4 may be accepted, in accordance with Article 105-3, for the specific mix types and areas listed directly above.

610-11 JOINTS

(A) Transverse Joints

When the placing of the mixture is to be suspended long enough to permit the mixture to become chilled, construct a transverse joint.

If traffic will not pass over the end of the paving, a butt joint will be permitted, provided proper compaction is achieved. If traffic will pass over the joint, construct a sloped wedge ahead of the end of the full depth pavement to provide for proper compaction and protection of the full depth pavement. Construct the joint square to

the lane alignment and discard all excess material. Place a paper parting strip beneath this wedge to facilitate joint construction unless waived by the Engineer.

Before paving operations are resumed, remove the sloped wedge and cut back into the previously constructed pavement to the point of full pavement depth. Coat the exposed edge of the previously constructed pavement with tack coat.

When laying of the mixture is resumed at the joint, complete and then test the construction of the joint in accordance with Article 610-12 while the mixture is still in a workable condition.

(B) Longitudinal Joints

Tack the exposed edge of all longitudinal joints prior to placing the adjoining pavement.

Form longitudinal joints by allowing the paver to deposit the mixture adjacent to the joint to such depth that maximum compaction can be obtained along the joint. Pinch the joint by rolling immediately behind the paver.

When multi-lane multi-layer construction is required, offset the longitudinal joints in each layer from that in the layer immediately below by approximately 6 inches. Construct the joints in the final layer, where possible, between designated travel lanes of the final traffic pattern.

610-12 SURFACE REQUIREMENTS AND ACCEPTANCE

Construct pavements using quality-paving practices as detailed herein. Construct the pavement surface smooth and true to the plan grade and cross slope. Immediately correct any defective areas with satisfactory material compacted to conform with the surrounding area.

Pavement imperfections resulting from unsatisfactory workmanship such as segregation, improper longitudinal joint placement or alignment, and non-uniform edge alignment, or excessive pavement repairs will be considered unsatisfactory and if allowed to remain in place will be accepted in accordance with Article 105-3.

When directed due to unsatisfactory laydown or workmanship, operate under the limited production procedures. Limited production for unsatisfactory laydown is defined as being restricted to the production, placement, compaction, and final surface testing (if applicable) of a sufficient quantity of mix necessary to construct only 2500 feet of pavement at the laydown width.

Remain on limited production until such time as satisfactory laydown results are obtained or until three consecutive 2500 foot sections have been attempted without achieving satisfactory laydown results. If the Contractor fails to achieve satisfactory laydown results after three consecutive 2500 foot sections have been attempted, cease production of that mix type until such time as the cause of the unsatisfactory laydown results can be determined. As an exception, the Engineer may grant approval to produce a different mix design of the same mix type if the cause is related to mix problem(s) rather than laydown procedures.

Mix placed under the limited production procedures for unsatisfactory laydown or workmanship will be evaluated for acceptance in accordance with Article l05-3.

Provide a surface of the pavement after compaction that conforms to the requirements below, except in the case where FINAL SURFACE TESTING - ASPHALT PAVEMENTS is included in the contract.

Each pavement layer will be tested by the Contractor and the Engineer using a 10-foot stationary straightedge furnished by the Contractor. Any location on the pavement selected by the Department shall be tested as well as all transverse joints. Apply the straightedge parallel to the centerline of the surface. Do not exceed 1/8 inch variation of the surface being tested from the edge of the straightedge between any 2 contact points. Correct areas found to exceed this tolerance by removal of the defective work and replacement with new material, unless other corrective measures are permitted. Provide the work and materials required in the correction of defective work at no cost to the Department.

610-13 DENSITY ACCEPTANCE

The Department will evaluate the asphalt pavement for density acceptance after the asphalt mix has been placed and compacted using the Contractor's quality control test results, the Department's quality assurance test results, including verification samples, and by observation of the Contractor's density quality control process conducted in accordance with Section 609. Minimum density requirements for all mixes will be as specified in Article 610-10, Table 610-4. Density acceptance will be as provided herein. Core sample densities will be determined by use of the average maximum specific gravity (Gmm), until a moving average of the last four maximum specific gravities is established. Once a moving average of the last four maximum specific gravities is established, the last Gmm moving average in effect at the end of the same day's production will then be used to determine density acceptance.

The pavement will be accepted for density on a lot by lot basis. A lot will consist of one day’s production of a given job mix formula on a contract. As an exception, separate lots will be established when the one of the following occurs:

(A) Portions of pavement are placed in both New and Other construction categories as defined below. A lot will be established for the portion of the pavement in the New construction category and a separate lot for the portion of pavement in the Other construction category.

(B) Pavement is placed on multiple resurfacing maps, unless otherwise approved prior to paving. A lot will be established for each individual resurfacing map or portion thereof.

(C) Pavement is placed by multiple paving crews. A lot will be established for the pavement placed by each paving crew.

(D) Pavement is placed in different layers. A lot will be established for each layer.

(E) Control strips are placed during limited production.

The Engineer will determine the final category and quantity of each lot for acceptance purposes.

The New construction category will be defined as pavements of uniform thickness, exclusive of irregular areas, meeting all three of the following criteria:

(A) pavement placed on a new aggregate or soil base compacted to the specified density or pavement placed on a new asphalt mix layer (excluding wedging and leveling);

(B) pavement that is within a designated travel lane of the final traffic pattern; and

(C) pavement that is 4.0 feet or wider.

As an exception, when the first layer of mix is placed on an unprimed aggregate base and is 2.0 inches or less in thickness, the layer will be included in the Other construction category.

The Other construction category will include all pavements except as described above.

A failing lot for density acceptance purposes is defined as a lot for which the average of all test sections, and portions thereof, fails to meet the minimum specification requirement. If additional density sampling and testing, beyond the minimum requirement, is performed and additional test sections are thereby created, then all test results shall be included in the lot average. In addition, any lot or portion of a lot that is obviously unacceptable will be rejected for use in the work.

If the Engineer determines that a given lot of mix that falls in the New category does not meet the minimum specification requirements but the work is reasonably acceptable, the lot will be accepted at a reduced pay factor in accordance with the following formula. The reduced pay factor will apply only to the mix unit price.

$$PF = 100 - 10(D)^{1.465}$$

where: PF = Pay Factor (computed to 0.1%)
D = the deficiency of the lot average density, not to exceed 3.0%

Acceptance of all failing lots in the Other category will be made under the requirements of Article 105-3.

Any density lot not meeting minimum density requirements detailed in Table 610-4 will be evaluated for acceptance by the Engineer. If the lot is determined to be reasonably acceptable, the mix will be paid at an adjusted contract price in accordance with Article 105-3. If the lot is determined not to be acceptable, the mix will be removed and replaced with mix meeting and compacted to the requirement of these Specifications.

Any reduction in pay due to failing density will be in addition to any reduction in pay due to failing mix property test results on the same mix.

Perform the production and construction of all asphalt mixtures and pavements in accordance with these provisions. There will be no direct payment for work covered by this provision.

MAINTENANCE

Maintain the plant mix pavement in an acceptable condition until final acceptance of the project. Immediately repair any defects or damage that may occur. Perform maintenance to damaged or defective pavement and repeat as often as may be necessary to keep the base or pavement in an acceptable condition at no cost to the Department.

610-15 MEASUREMENT AND PAYMENT

Hot Mix Asphalt Pavement will be paid for at the contract unit price per ton that will be the actual number of tons of each type of hot mix asphalt pavement that has been incorporated into the completed and accepted work pursuant to the requirements of Article 106-7.

No direct payment will be made for providing and using the materials transfer vehicle or any associated equipment, as the cost of providing same shall be included in the contract unit bid price per ton for the mix type to be placed.

A high frequency of asphalt plant mix, density, or mix and density deficiencies occurring over an extended duration of time may result in future asphalt, that is represented by mix and/or density test results not in compliance with minimum specification requirements, being excluded from acceptance at an adjusted contract unit price in accordance with Article 105-3. This acceptance process may apply to all asphalt produced and /or placed and may continue until the Engineer determines a history of quality asphalt production and placement is reestablished.

Furnishing asphalt binder will be paid for as provided in Article 620-5 for *Asphalt Binder for Plant Mix* for each grade required.

Payment will be made under:

Pay Item	**Pay Unit**
Asphalt Concrete Base Course, Type B 25.0B	Ton
Asphalt Concrete Base Course, Type B 25.0C	Ton
Asphalt Concrete Base Course, Type B 37.5C	Ton
Asphalt Concrete Intermediate Course, Type I 19.0B	Ton
Asphalt Concrete Intermediate Course, Type I 19.0C	Ton
Asphalt Concrete Intermediate Course, Type I 19.0D	Ton
Asphalt Concrete Surface Course, Type S 4.75A	Ton
Asphalt Concrete Surface Course, Type SF 9.5A	Ton
Asphalt Concrete Surface Course, Type S 9.5B	Ton
Asphalt Concrete Surface Course, Type S 9.5C	Ton
Asphalt Concrete Surface Course, Type S 9.5D	Ton
Asphalt Concrete Surface Course, Type S 12.5C	Ton
Asphalt Concrete Surface Course, Type S 12.5D	Ton

SECTION 620
ASPHALT BINDER FOR PLANT MIX

620-1 DESCRIPTION

Perform the work covered by this section including but not limited to furnishing of asphalt binder, with anti-strip additive when required, at an asphalt plant and incorporating the asphalt binder and anti-strip additive into the asphalt plant mix.

620-2 MATERIALS

Refer to Division 10

Item	Section
Asphalt Binder, All Grades	1020-2
Anti-strip Additive (Chemical)	1020-8
Anti-strip Additive (Hydrated Lime)	1012-1
Silicone	1020-4

The asphalt binder for the mixture will be accepted at the source subject to the requirements of Article 1020-1.

620-3 GENERAL REQUIREMENTS

The requirements of Section 610 that pertain to handling of asphalt binder will be applicable to the work covered by this section.

Add silicone to all asphalt binder used in surface courses and open-graded asphalt friction course, unless otherwise directed. The amount of silicone added will range from 1 oz. per 2,000 gallons of asphalt binder to 1 oz. per 2,500. Add silicone to the asphalt binder at the plant site unless added at the source and it is so noted on the delivery ticket. Use a brand of silicone from the approved list published by the Materials and Tests Unit. Submit a sample and manufacturer's data to the Engineer for approval prior to use if proposing to use a brand not on the approved list.

When required, incorporate an anti-strip additive. It may be either chemical additive mixed with the asphalt binder or hydrated lime added to the aggregate or a combination of both.

Do not heat the asphalt binder to a temperature in excess of the supplier’s recommendation while stored or when being used in production of mix at the asphalt plant.

Introduce the actual quantity of asphalt binder at the established percentage shown on the applicable job mix formula into the mix by the plant weighing or metering system. No working tolerance for asphalt binder percentage will be allowed during production.

Furnish the brand name of the type (lime or chemical), supplier, and shipping point of anti-strip additive. Note on the asphalt binder delivery ticket the rate (or quantity), brand of chemical additive when added at the supplier’s terminal.

Introduce and mix chemical anti-strip additive into the asphalt binder at either the supplier's terminal or at the asphalt plant site at the dosage required by the JMF. Use in-line blending equipment at either location. When added at the asphalt plant, use equipment that meets the requirements of Subarticle 610-5(B). When added at the supplier's terminal, use equipment that in-line blends the additive for a minimum of 80% of the asphalt binder loading time.

When hydrated lime is used, use equipment to introduce the lime that meets the requirements of Subarticle 610-5(B).

Thoroughly mix chemical anti-strip additive and asphalt binder together before incorporating into the asphalt plant mix.

620-4 MEASUREMENT AND PAYMENT

Asphalt Binder for Plant Mix, Grade PG ___ will be measured and paid for as the theoretical number of tons of the grade of asphalt binder required by the applicable job mix formula based on the actual number of tons of plant mix completed and accepted on the job.

Where recycled plant mix is being produced, the grade of asphalt binder to be paid for will be the grade for the specified mix type as required in Table 610-2 unless otherwise approved. The theoretical number of tons of the grade of asphalt binder to be paid for will include additional new asphalt binder, salvaged asphalt binder from the reclaimed asphalt pavement material, and salvaged asphalt from the reclaimed shingle material.

Such price and payment will be full compensation for all work covered by this section.

There will be no direct payment for anti-strip additive. Payment at the contract unit prices for the various asphalt plant mix items will be full compensation for the work.

Adjustments will be made to the payments due the Contractor for each grade of asphalt binder when it has been determined that the monthly average terminal F.O.B. Selling Price of asphalt binder, Grade PG 64-22, has fluctuated from the Base Price Index for Asphalt Binder included in the contract. The methods for calculating a base price index, for calculating the monthly average terminal F.O.B. selling price and for determining the terminals used are in accordance with procedures on file with the Department's Construction Unit.

When it is determined that the monthly selling price of asphalt binder on the first business day of the calendar month during that the last day of the partial payment period occurs varies either upward of downward from the base price index, the contract unit price for asphalt binder for plant mix will be adjusted. The adjusted contract unit price will be determined by adding the difference between the selling price and the base price index to the contract unit bid price for asphalt binder. If the selling price is less than the base price index, the adjusted contract unit price will be determined by subtracting the difference between the selling price and the base price index from the contract unit price for asphalt binder.

The adjusted contract unit price will then be applied to the total theoretical quantity of asphalt binder authorized for use in the plant mix placed during the partial payment period

involved, including both additional new asphalt binder and salvaged asphalt binder from reclaimed asphalt materials required by the job mix formula.

Adjusted contract unit prices for all grades of asphalt binder, including additional asphalt binder materials in recycled mixtures, will be based on the average selling price and base price index for asphalt binder, Grade PG 64-22, regardless of the actual grade required by the job mix formula.

In determining the adjusted contract unit price for any material specified in this provision the following formula will be used:

$$A = B + (D - C)$$

Where
A = Adjusted Contract Unit Price
B = Contract Unit Price
C = Base Price Index
D = Monthly Average Terminal F.O.B. Selling Price

In the event the Department is unable to secure an F.O.B. selling price from at least four terminals in a given month, payment will be at the contract unit price for each ton of asphalt binder used in the work during that month.

Payment will be made under:

Pay Item	Pay Unit
Asphalt Binder for Plant Mix, Grade PG 64-22	Ton
Asphalt Binder for Plant Mix, Grade PG 70-22	Ton
Asphalt Binder for Plant Mix, Grade PG 76-22	Ton

SECTION 650
OPEN-GRADED ASPHALT FRICTION COURSE, TYPES FC-1, FC-1 MODIFIED, AND FC-2 MODIFIED

650-1 DESCRIPTION

Perform the work covered by this section including but not limited to construction of a plant mixed open-graded asphalt friction course (OGAFC) properly laid upon a prepared surface in accordance with these Specifications and in conformity with the lines, grades, thickness, and typical sections shown on the plans; producing, weighing, transporting, placing, and rolling the plant mix as specified in Section 610; furnishing the asphalt binder, anti-strip additive, fiber stabilizing additive, and all other materials for the plant mix; furnishing and applying tack coat as specified in Section 605; providing quality control as specified in Section 609 as modified for OGAFC; surface testing of the completed pavement; furnishing scales; making any repairs or corrections to the friction course that may become necessary, and maintaining the friction course until final acceptance of the project.

650-2 MATERIALS

See Division 10

Item	Section
Asphalt Binder, Grade PG 64-22, PG 76-22	1020-2
Anti-strip Additive (Chemical)	1020-8
Anti-strip Additive (Hydrated Lime)	1012-1
Coarse Aggregate	1012-1
Mineral Filler	1012-1
Stone Screenings	1012-1

Fiber Stabilizing Additives:

Use fiber stabilizing additives that are capable of stabilizing the asphalt film surrounding the aggregate particles in order to reduce drain-down of the asphalt binder. A fiber stabilizer such as mineral fiber or cellulose may be used. The selected fiber shall meet the properties described below. Dosage rates given are typical ranges but the actual dosage rate used will be approved by the Engineer.

(A) MINERAL FIBERS

Mineral fibers shall be made from virgin basalt, diabase, or slag and that have been treated with a cationic sizing agent to enhance disbursement of the fiber as well as increase adhesion of the fiber surface to the asphalt binder. Add the fiber at a dosage rate between 0.2% to 0.4% by weight of total mix, as approved.

(1) Size Analysis

Average Fiber length:	0.25 inches maximum
Average Fiber thickness:	0.0002 inches maximum

(2) Shot Content (ASTM C 612)

Passing No. 60 sieve	90- 100%
Passing No. 230 sieve	65- 100%

(3) Degradation (GDT-124/McNett Fractionation) 30% (maximum)

(B) CELLULOSE FIBERS

Add cellulose fibers at a dosage rate between 0.2% and 0.4% by weight of total mix as approved. Fiber properties shall be as follows:

(1) Fiber length 0.25 inches maximum

(2) Sieve Analysis

(a) Alpine Sieve Method

Passing No. 100 sieve	60-80%

(b)	Ro-Tap Sieve Method	
	Passing No. 20 Sieve	80-95%
	Passing No. 40 Sieve	45-85%
	Passing No. 100 Sieve	5-40%
(3)	Ash Content	18% non-volatiles (±5%)
(4)	pH	7.5 (±1)
(5)	Oil Absorption (times fiber weight)	5.0 (±1)
(6)	Moisture Content	5.0 (maximum)

(C) CELLULOSE PELLETS

Cellulose pellets consist of a 50/50 blend of cellulose fiber and asphalt binder. Use cellulose that complies with Item (B), Cellulose Fibers, above. Add the cellulose pellets at a dosage rate between 0.4% and 0.8% by weight of total mix, as approved.

(1)	Pellet Size	1/4 cubic inch (maximum)
(2)	Asphalt	25 – 80 pen.

650-3 COMPOSITION OF MIXTURE (MIX DESIGN & JOB MIX FORMULA)

(A) General

Design the open-graded asphalt friction course utilizing a mixture of coarse and fine aggregate, asphalt binder, mineral filler, fiber stabilizing additive, and other additives as required to produce a mix meeting the requirements of Table 650-1.

Submit in writing a mix design and proposed job mix formula (JMF) targets for each required mix type and combination of aggregates to the Engineer for review and approval at least 10 days prior to start of asphalt mix production. The mix design shall be prepared by a mix design technician approved by the Department in an approved mix design laboratory. Perform the mix design in accordance with applicable requirements of Article 610-3 and the Department's mix design procedures titled DETERMINATION OF OPTIMUM ASPHALT CONTENT FOR OPEN-GRADED ASPHALT FRICTION COURSES. A copy of these procedures can be obtained through the Department's Materials and Tests Unit. Submit the mix design and proposed job mix formula targets on forms and in a format approved by the Department.

The mix design and job mix formula target values will be established within the mix design criteria specified in Table 650-1 for the particular type mixture to be produced. The formula for each mixture will indicate the blend percentage of each aggregate fraction to be used, a single percentage of combined aggregate passing each required sieve, the percentage and grade of asphalt binder (by weight of total mixture) to be incorporated into the mixture, the percentage of anti-strip additive to be added to the asphalt binder, the percentage of fiber stabilizing additive (by weight

of total mix), and the temperature at that the mixture is to be discharged from the plant.

Have on hand at the asphalt plant the approved mix design and job mix formula issued by the Department, prior to beginning the work.

The job mix formula for each mixture shall remain in effect until modified in writing, provided the results of QMS tests performed on material currently being produced conform with specification requirements.

Should a change in sources of aggregate materials to be made, a new mix design and job mix formula will be required before the new mixture is produced.

When unsatisfactory results or other conditions make it necessary, the Engineer may establish a new job mix formula.

(B) Mix Design Criteria

Design open-graded asphalt friction course mixtures conforming to the gradation requirements and other mix design criteria in Table 650-1 for the mix type specified.

Use the asphalt binder grade shown in Table 650-1 for the mix type specified.

Use an anti-strip additive in all OGAFC mixes. It may be hydrated lime or a chemical additive or both. Add chemical anti-strip additive at a rate of 0.5% by weight of asphalt binder. Add hydrated lime at a rate of 1.0% by weight of dry aggregate. Use approved source and grade.

Incorporate a fiber stabilizing additive into all OGAFC types. Add the fiber at a dosage rate by weight of the total mix as approved.

When requested, submit to the Materials & Tests Unit in Raleigh, samples of mix components. Submit sample sizes as noted below or as requested. Provide the samples at least 20 days prior to the anticipated beginning placement of OGAFC mixture.

250 lb. of each coarse aggregate
150 lb. fine aggregate
1 gal. of mineral filler and/or baghouse fines
1 gal. of hydrated lime
1 pint of chemical anti-strip additive
4 lb. of fiber stabilizing additive

Aggregate samples when combined according to the Contractor's proposed aggregate blend percentages shall be within the gradation range defined by the target values of Table 650-1 for each sieve or the samples will not be considered representative.

The mixing temperature at the asphalt plant will be established on the job mix formula.

Add the anti-strip additive to the asphalt binder in accordance with Article 620-3.

TABLE 650-1
OGAFC MIX DESIGN CRITERIA

Grading Requirements	**Total Percent Passing**		
Sieve Designations	**Type FC-1**	**Type FC-1 Modified**	**Type FC-2 Modified**
3/4 inch			100
1/2 inch	100	100	85-100
3/8 inch	75-100	75-100	55-75
No. 4	25-45	25-45	15-25
No. 8	5-15	5-15	5-10
No. 200	1.0-3.0	1.0-3.0	2.0-4.0
Design Requirements			
Asphalt Binder,			
Performance Grade	PG 64-22	PG 76-22	PG 76-22
Asphalt Binder, % Range	5.0-8.0	5.0-8.0	5.0-8.0
Mixing Temperature Range	200 - 275°F	300 - 350°F	300 - 350°F
(To be established by the			
Engineer)			
Draindown, Percent	0.3 max.	0.3 max.	0.3 max.
(AASHTO T 305)			

650-4 PLANT EQUIPMENT

Use plant equipment in accordance with Article 610-5 and the following requirements:

When fiber stabilizing additives are required as an ingredient of the mixture, utilize a separate feed system capable of accurately proportioning the required quantity into the mixture and in such a manner that uniform distribution will be obtained. Interlock the proportioning device with the aggregate feed or weigh system so as to maintain the correct proportions for all rates of production and batch sizes. Accurately control the proportion of fibers to within plus or minus 10 percent of the amount required. Provide flow indicators or sensing devices for the fiber system that are interlocked with plant controls such that mixture production will be interrupted if introduction of the fiber fails.

When a batch type plant is used, add the fiber to the aggregate in the weigh hopper or as approved. Increase the batch dry mixing time by 8 to 12 seconds, or as directed, to assure the fibers are uniformly distributed prior to the injection of asphalt binder into the mixer.

When a continuous mix or dryer-drum type plant is used, add the fiber to the aggregate and uniformly disperse at the point of injection of asphalt binder. Add the fiber in such a manner that it will not become entrained in the exhaust system of the drier or plant.

650-5 CONSTRUCTION REQUIREMENTS

Produce, transport to the site, and place the OGAFC in accordance with the applicable requirements of Section 610, except as otherwise provided below.

Do not place open-graded asphalt friction course between October 31 and April 1 of the next year, unless otherwise approved. Place friction course, Type FC-1 mixes, only when the road surface temperature is 50°F or higher and the air temperature measured in the shade away from artificial heat is 50°F or higher. The minimum air and road surface temperature for placing Type FC-1 Modified and FC-2 Modified mixes will be 60°F.

Prior to starting production of the mix, stockpile all aggregates for a sufficient period of time to facilitate the drainage of free moisture.

Produce the mixture at the asphalt plant within ±15°F of the temperature established on the JMF. Assure the temperature of the mix immediately prior to discharge from the hauling vehicle is within +15°F to -25°F of the JMF temperature.

Add the anti-strip additive to the asphalt binder in accordance with Article 620-3.

Clean the existing surface in an acceptable manner prior to placement of any asphalt material.

Remove all existing raised pavement markers as directed and repair any damaged areas caused by the removal. Use an approved dense graded mixture of similar type material for the repair.

Apply tack coat in accordance with the requirements of Section 605 and the following

(A) Use Asphalt Binder, Grade PG 64-22 tack coat material or as approved.

(B) Uniformly apply the tack coat material at a rate of application 0.06 to 0.08 gal. per square yard, as directed.

Spread and finish the friction course as specified in Article 610-8.

Roll the friction course as specified in Article 610-9.

Use a Material Transfer Vehicle (MTV) when placing all asphalt concrete plant mix pavements, including open-graded asphalt friction course, that require the use of asphalt binder grade PG 76-22, unless otherwise approved. Utilize the MTV when placing all full width travel lanes, including shoulders, collector lanes, ramps, and loops that require PG 76-22.

Provide an MTV that receives mixture from the hauling equipment and independently delivers the mixture from the hauling equipment to the paving equipment. Provide an MTV capable of transferring the material from the haul vehicle to the paver hopper at a uniform and continuous rate to allow the continuous movement of the paver. Install a paver hopper insert with a minimum capacity of 7 tons in the hopper of conventional paving equipment when utilizing a MTV. Perform remixing of the material prior to discharge into the paver

conveyor system by utilizing either a MTV with a remixing system contained within a minimum 7 ton capacity storage bin or a dual pugmill system with two full length transversely mounted paddle mixers located in the paver hopper insert.

Use an MTV that provides to the paver a homogeneous, non-segregated mixture that is of uniform temperature such that there is no more than 20°F difference between the highest and lowest temperatures when measured transversely across the width of the mat in a straight line at a distance of one foot to three feet from the screed while the paver is operating. Obtain the temperature measurements approximately one foot from each edge and at least once in the middle of the mat.

Empty the MTV when crossing a bridge and move across without any other Contractor vehicles or equipment being on the bridge. Move the MTV across a bridge in a travel lane and not on the shoulder. While crossing a bridge move the MTV at a speed no greater than five miles per hour without any abrupt acceleration or deceleration.

In the event the MTV malfunctions during paving operations, immediately discontinue plant operations and do not resume operations until the MTV malfunctions have been remedied, unless otherwise directed due to safety concerns. The Contractor may continue placement of the mix until any additional mix in transit has been placed, provided satisfactory results are achieved. This procedure in no way alleviates the Contractor from meeting contract requirements.

Remove and replace any part of the finished friction course that shows non-uniform distribution of asphalt binder, aggregate or fiber at no additional cost to the Department.

Coordinate plant production, transportation, and paving operations such that uniform continuity of operation is maintained. If spreading operations are interrupted, the Engineer may require that a transverse joint be constructed any time the mixture immediately behind the paver screed cools to less than 250ºF.

When OGAFC, Type FC-2 Modified mixture is specified, use OGAFC, Type FC-1 Modified on entrance and exit ramps, gore areas, and at end of project construction joints. Adjust the thickness of placement as specified below.

For end of project joints, provide a transition area consisting of one load of mixture per lane, or as directed. Taper the mixture in thickness from 3/8 inch at the end of the project to the typical thickness (approximately 3/4 inch) within the maximum distance of spread for one load of mixture. For ramps and gore areas, taper the mixture in thickness from that at the edge of the mainline, approximately 3/4 inch to 3/8 inch at the point of the ramp transverse joint. Construct the ramp transverse joint at a point specified by the plans or as directed.

650-6 QUALITY MANAGEMENT SYSTEM

Produce the OGAFC in accordance with the applicable requirements of Section 609 and QMS for ASPHALT PAVEMENTS: (OGAFC, PADC, and ULTRATHIN VERSION) as shown in the contract.

650-7 MEASUREMENT AND PAYMENT

Open-Graded Asphalt Friction Course, Type FC-1, Type FC-1 Modified, or Type FC-2 Modified will be measured and paid for as the actual number of tons of friction course that has been incorporated into the completed and accepted work. The friction course will be measured by being weighed in trucks on certified platform scales or other certified weighing devices.

Furnishing asphalt binder for the mix will be paid for as provided in Article 620-4 Asphalt Binder for Plant Mix, Grade PG XX-XX. Adjustments in contract unit price due to asphalt binder price fluctuation will be made in accordance with Section 620.

No direct payment will be made for providing and using the materials transfer vehicle or any associated equipment, as the cost of providing same shall be included in the contract unit bid price per ton for the mix type to be placed.

Providing QMS for asphalt pavements will be in accordance with QMS for Asphalt Plant Mix Pavements contained elsewhere in the contract.

Payment will be made under:

Pay Item	Pay Unit
Open-Graded Asphalt Friction Course, Type FC-1	Ton
Open-Graded Asphalt Friction Course, Type FC-1 Modified	Ton
Open-Graded Asphalt Friction Course, Type FC-2 Modified	Ton

SECTION 652
PERMEABLE ASPHALT DRAINAGE COURSE
TYPES P-78M AND P-57

652-1 DESCRIPTION

Perform the work covered by this section including but not limited to the construction of a plant mixed permeable asphalt drainage course (PADC) properly laid upon a prepared surface in accordance with these Specifications and in conformity with the lines, grades, thickness, and typical sections shown on the plans; producing, weighing, transporting, placing, and rolling the plant mix as specified in Section 610; furnishing the asphalt binder, anti-strip additive, and all other materials for the plant mix; furnishing and applying tack coat as specified in Section 605; furnishing scales; providing quality control as specified in Section 609 as modified for PADC; making any repairs or corrections to the friction course that may become necessary; and maintaining the friction course until final acceptance of the project.

652-2 MATERIALS

See Division 10:

Item	Section
Coarse Aggregate	1012-1
Fine Aggregate	1012-1
Asphalt Binder, Grade PG 64-22	1020-2
Anti-strip Additive (Chemical)	1020-8

The coarse aggregate shall meet the requirements of Article 1012-1 except that that portion of the coarse aggregate retained on the No. 4 sieve shall contain at least 60 percent by weight of crushed pieces having 2 or more mechanically induced fractured faces.

652-3 COMPOSITION OF MIXTURE

(A) General

Formulate the permeable asphalt drainage course from a mixture of crushed aggregate, asphalt binder, anti-strip additive and other additives as required to produce a mix meeting the requirements of Table 652-1.

Submit in writing a mix design (M&T 601 only) and proposed job mix formula (JMF) targets for each required mix type and combination of aggregates to the Engineer for review and approval at least 10 days prior to start of asphalt mix production. The job mix formula (JMF) will be established in accordance with the applicable requirements of Article 610-3. Establish the asphalt binder content at the midpoint of the range specified in Table 652-1 or as approved. Submit the mix design and proposed job mix formula targets on forms and in a format approved by the Department.

The formula for each mixture will indicate the blend percentage of each aggregate fraction to be used, a single percentage of combined aggregate passing each required sieve, the percentage and grade of asphalt binder (by weight of total mixture) to be incorporated into the mixture, the percentage of anti-strip additive to be added to the asphalt binder, and the temperature at that the mixture is to be discharged from the plant.

Have on hand at the asphalt plant the approved mix design and job mix formula issued by the Department, prior to beginning the work.

The job mix formula for each mixture will remain in effect until modified in writing, provided the results of QMS tests performed on material currently being produced conform with specification requirements.

Should a change in sources of aggregate materials to be made, a new mix design and job mix formula will be required before the new mixture is produced.

When unsatisfactory results or other conditions make it necessary, the Engineer may establish a new job mix formula.

(B) Mix Design

Design PADC mixtures conforming to the gradation requirements and other mix design criteria in Table 652-1 for the mix type specified.

Use the asphalt binder grade shown in Table 652-1 for the mix type specified or as approved.

Use a chemical anti-strip additive at a rate of 0.5% by weight of asphalt binder in all PADC mixes

When requested, submit to the Materials & Tests Unit in Raleigh, samples of mix components. Submit sample sizes as noted below or as requested. Provide the samples at least 20 days prior to the anticipated beginning placement of PADC mixture.

250 lb. of each coarse aggregate
150 lb. fine aggregate
2 gal. of asphalt binder
1 pint of chemical anti-strip additive

Aggregate samples when combined according to the Contractor's proposed aggregate blend percentages shall be within the gradation range defined by the target values of Table 652-1 for each sieve or the samples will not be considered representative.

The mixing temperature at the asphalt plant will be established on the job mix formula.

TABLE 652-1
PERMEABLE ASPHALT DRAINAGE COURSE

Sieve Designation	Total Percent Passing	
	Type P 78M	**Type P 57**
1 1/2"		100
1"		95 – 100
3/4"	100	
1/2"	95 - 100	25 – 60
3/8"	75 - 100	
No. 4	20 - 45	10 – 20
No. 8	3 - 15	5 – 10
No. 200	1.0 – 3.0	1.0 – 3.0
Asphalt Binder Content, %	2.5 - 3.5	2.0 - 3.0
Mixing Temperature at Plant (Established by the Engineer)	240 - 270°F	260 - 290°F

652-4 CONSTRUCTION REQUIREMENTS

Produce, transport to the site, and place the asphalt plant mix in accordance with the applicable requirements of Section 610, except as otherwise provided below.

Produce the mixture at the asphalt plant within ±15°F of the temperature established on the JMF. Assure the temperature of the mix immediately prior to discharge from the hauling vehicle is within +15°F to -25°F of the JMF temperature.

Incorporate the asphalt binder into the asphalt plant mix in accordance with Section 620. Add the anti-strip additive to the asphalt binder in accordance with Article 620-3.

A prime coat or tack coat will not be required.

When the PADC is placed in trench sections, the rolling equipment and rolling sequences required by Article 610-9 will not apply. Compact the PADC to a degree acceptable to the Engineer.

When the PADC is to be covered with a subsequent layer of pavement, following placement of the PADC mixture to the appropriate line, grade and thickness, begin rolling when the mat has cooled sufficiently to support the weight of an 8 to 12 ton steel wheel tandem roller. Mat temperature at the time of initial rolling should be approximately 175°F - 225°F. The number of roller passes will be 2 or 3, unless otherwise directed. Consolidate the drainage layer sufficiently with rolling so as to support the weight of equipment that will place the next layer of pavement. Do not compact the drainage layer to the extent that it is not free draining or that the aggregate is crushed.

No construction traffic will be allowed to travel on any permeable asphalt drainage course. Only equipment necessary to place the next layer of pavement will be allowed on the drainage layer.

Do not place PADC that will not be covered with the next layer of pavement during the same calendar year or within 15 days of placement if the PADC is placed in January or February.

652-5 QUALITY MANAGEMENT SYSTEM FOR ASPHALT PAVEMENTS

Produce the PADC in accordance with the applicable requirements in Section 609 and QMS for ASPHALT PAVEMENTS: (OGAFC, PADC, and ULTRATHIN VERSION)".

652-6 MEASUREMENT AND PAYMENT

Permeable Asphalt Drainage Course, Type ___ will be paid for as the actual number of tons of drainage course that has been incorporated into the completed and accepted work. The drainage course will be measured by being weighed in trucks on certified platform scales or other certified weighing devices.

Asphalt Binder for Plant Mix, Grade PG 64-22 will paid for in accordance with Article 620-4.

Payment will be made under

Pay Item	Pay Unit
Permeable Asphalt Drainage Course, Type P-78M	Ton
Permeable Asphalt Drainage Course, Type P-57	Ton

SECTION 654
ASPHALT PLANT MIX, PAVEMENT REPAIR

654-1 DESCRIPTION

Perform the work covered by this section including but not limited to repairing of existing pavement with asphalt plant mix in order to provide a safe, passable, and convenient condition for traffic, or to replace pavement that has been removed in order to remove or to place pipe lines.

Perform the work by cutting of the existing pavement to a neat vertical joint and uniform line; removing and disposing of pavement, base, and subgrade material as approved or directed; coating of the area to be repaired with a tack coat; furnishing, placing, and compacting of asphalt plant mix; furnishing of asphalt binder for the asphalt plant mix; furnishing scales; and replacement of the removed material with asphalt plant mix.

Make the repairs in accordance with the plans, or as approved or directed.

654-2 MATERIALS

Where a pavement repair detail is not shown in the plans, use a type of asphalt plant mix that has have been approved.

Where a pavement repair detail is shown in the plans, the type of plant mix shall be in accordance with the pavement repair detail except where the Specifications permit the substitution of another type of plant mix or where approved.

In areas where the existing pavement is not to be resurfaced, the Contractor will not be allowed to substitute a different type of surface course from that shown on the pavement repair detail.

654-3 CONSTRUCTION METHODS

(A) General

Perform repair of existing pavement as approved or directed. Coordinate the work with all other work and operations necessary to maintain traffic.

(B) Pipe Removal or Installation

Where traffic is to be maintained, perform the removal or installation of pipe in sections so that half the width of the roadway will be available to traffic. Immediately upon completion of the entire pipeline removal or installation, repair the pavement.

654-4 MEASUREMENT AND PAYMENT

Asphalt Plant Mix, Pavement Repair will be paid for as the actual number of tons of asphalt plant mix, complete in place, that has been used to make completed and accepted repairs, except for those repairs that have been made necessary by the contractor's negligence. The asphalt plant mixed material will be measured by being weighed in trucks on certified platform scales or other certified weighing devices.

Any requirements included in the contract that provide for adjustments in compensation due to variations in the price of asphalt cement will not be applicable to payment for the work covered by this section.

Payment will be made under:

Pay Item	Pay Unit
Asphalt Plant Mix, Pavement Repair	Ton

SECTION 657
SEALING EXISTNG PAVEMENT CRACKS AND JOINTS

657-1 DESCRIPTION

The work consists of sealing existing longitudinal and transverse pavement cracks and joints with PS/AR (hot-poured rubber asphalt) at locations as directed by the Engineer. The Contractor will not be required to seal the existing edge joints.

657-2 MATERIALS

Item	Section
PS/AR (Hot-Poured Rubber Asphalt	1012-1

The sealant is to be packaged in polyethylene bags and placed in boxes that weigh approximately 60 pounds. The sealant may be packed in 60 pound boxes containing two polyethylene bags of sealant that weigh approximately 30 pounds each. Boxes of sealant are to be palletized for shipment. The pallets are to be protected with a weatherproof covering. The Contractor is responsible for storage.

657-3 CONSTRUCTION METHODS

Install the sealant so that it forms a complete watertight bond with a high degree of elasticity, with maximum flexibility and longevity under extreme temperature ranges.

Use a hot compressed air (HCA) lance at all times to blast out any vegetation, dirt, dampness and loose materials from the cracks and joints.

Use a concentrated hot air jet that is a minimum of 3000°F in temperature and that has a minimum air jet force of 3000 feet per second of blasting.

Force open asphalt cracks and joints, clean warm and dry, and have ready for the application of the preheated sealant for maximum crack sealing potential.

Preheat the sealant to its application temperature, using the air jacketed flow method to prevent the burning of the modified rubber in the sealant. Perform this by means of a trailer mounted 190 gallon safety tested crack sealant preheater melter kettle, with a horizontally mounted full sweep double paddle agitator.

Apply sealant in the prepared cracks and joints at a temperature range of 370°F minimum and 420°F maximum, using the pressure screed shoe to completely fill the crack and joint, leaving a sealed 2" overband. Excessive overbanding or waste of sealant materials will not be tolerated. Immediately squeegee the crack seal material to minimize the height of the overband.

Do not apply the PS/AR sealant when the surface temperature of the pavement is below 32°F. Follow manufacturer's recommendations.

All cracks and joints sealed must have a minimum of 1/8" depth of sealant installed.

After the crack and joint has been sealed, promptly remove any surplus sealer on the pavement. Do not permit traffic over the sealed cracks and joints without approval by the Engineer. Sand or manufacturer's recommended material may be applied on top of the sealant to prevent traffic pick-up.

657-4 MEASUREMENT AND PAYMENT

*Sealing existing pavement cracks and j*oints will be measured and paid for as the actual number of pounds of material that has satisfactorily been used to seal pavement cracks and joints in the designated highway. Any material that has been spilled, used in excessive overbanding, wasted, misapplied, or unsatisfactorily used in any way will be deducted in determining quantities for payment. The Engineer will determine the quantity, if any, to be deducted. The Engineer's decision on the quantity to be deducted will be final and binding.

Payment will be made under:

Pay Item	Pay Unit
Sealing Existing Pavement Cracks and Joints	Pound

SECTION 660
ASPHALT SURFACE TREATMENT

660-1 DESCRIPTION

Perform the work covered by this section including but not limited to furnishing, hauling, spreading, and rolling the asphalt material and aggregate consisting of one or more applications of liquid asphalt material and one or more applications of aggregate cover coat material on a prepared surface; furnishing and spreading blotting sand; and maintaining and repairing the asphalt surface treatment.

660-2 MATERIALS

See Division 10

Use one of the following grades of asphalt

Item	Section
Emulsified Asphalt, Grade CRS-2	1020-7
Emulsified Asphalt, Grade CRS-2P	1020-7

Emulsified Asphalt, Grade CSS-1H	1020-7
Aggregate for Mat and Seal Coat	1012-2
Blotting Sand	1012-3
Fine Aggregate	1014
Mineral Filler	1012-1(D)
Water	1024-4

Before any asphalt surface treatment is placed, obtain from the asphalt supplier and furnish to the Engineer a certification of compatibility of the asphalt with the aggregate proposed for use.

660-3 WEATHER AND SEASONAL LIMITATIONS

Do not place any asphalt surface treatment between October 15 and March 16, except for asphalt surface treatment that is to be overlaid with asphalt plant mix.

Apply asphalt material only when the surface to be treated is dry and when the atmospheric temperature is above 60°F in the shade away from artificial heat.

When placing asphalt surface treatment that is to be subsequently overlaid with asphalt plant mix, the seasonal and temperature limitations of Article 610-4 will apply.

Do not apply asphalt material when the weather is foggy or rainy.

660-4 SURFACE PREPARATION

Clean the surface to be treated of all dust, dirt, clay, grass, sod, and any other deleterious matter prior to application of the asphalt surface treatment.

660-5 ACCEPTANCE OF ASPHALT MATERIALS

The acceptance of asphalt materials will be in accordance with the requirements of Section 1020-1.

660-6 APPLICATION EQUIPMENT

Use asphalt application equipment that meets the requirements of Article 600-5.

Apply aggregate by the use of a self-propelled, pneumatic tired aggregate spreader capable of maintaining a specified rate with a uniform application for the width of asphalt material being covered. Tailgate spreaders will not be permitted. Areas that are inaccessible to the aggregate spreader may be covered by hand spreading or other acceptable methods.

660-7 APPLICATION OF ASPHALT MATERIALS

The grades, rates of application, and the temperature at that the asphalt material is to be applied shall be within the limits shown in Table 660-1.

Base the required rates of application on the volume of material at the application temperature.

TABLE 660-1

MATERIAL APPLICATION RATES AND TEMPERATURES

TYPE OF COAT	GRADE OF ASPHALT	ASPHALT RATE GAL./SQ. YD. Total	APPLICA-TION TEMP. °F	AGGRE-GATE SIZE	AGGREGATER ATE LBS./SQ. YD. Total
Mat	CRS-2 or CRS-2P	0.35-0.45	150-175	No. 6*	30-35
	CRS-2 or CRS-2P	0.30-0.35	150-175	No. 67	35-45
	CRS-2 or CRS-2P	0.45-0.50	150-175	No. 5*	45-50
	CRS-2 or CRS-2P	0.30-0.40)	150-175	No. 78M*	15-20
Straight Seal	CRS-2 or CRS-2P	0.35-0.40	150-175	No. 78M	16-22
	CRS-2 or CRS-2P	0.35-0.40	150-175	Lightweight	9-12
Split Seal	CRS-2 or CRS-2P	0.5-0.60	150-175	No.78M	30-35
	CRS-2 or CRS-2P	0.45-0.60	150-175	Lightweight	18-20
Triple Seal	CRS-2 or CRS-2P	0.60-0.75	150-175	No. 78M	45-51
	CRS-2 or CRS-2P	0.60-0.75	150-175	Lightweight	27-29

* Use No. 6 or No. 78M aggregate for retreatment prior to an overlay on existing pavement.
Use No. 5 aggregate for initial treatment on new construction.

The Construction Methods article, 660-9, includes more detailed information regarding variations of the types of coats.

660-8 APPLICATION OF AGGREGATES

The size of the aggregate shall be as shown in Table 660-1 for the mat coat or the type of seal coat to be constructed.

The rate of application for mat and seal aggregates shall be within the limits shown in Table 660-1.

When directed, weigh a sufficient number of truck loads of aggregate prior to spreading to verify that the rate of application is within the required limits.

660-9 CONSTRUCTION METHODS

(A) Asphalt Mat Coat

The surface on that the mat coat is to be applied shall be approved by the Engineer before the mat coat liquid asphalt is applied.

Place a string line guide for application equipment unless otherwise permitted.

Place the mat coat in full-lane widths unless otherwise permitted.

Immediately follow the application of mat liquid asphalt with the spreading of the aggregate. No more than 5 minutes can elapse from the time the liquid asphalt is applied until the aggregate is spread.

Test the mat coat aggregate, have it approved, and make sure it is drained of free moisture prior to use. Spread the aggregate uniformly at the required rate and correct all non-uniform areas prior to rolling.

Roll immediately after the aggregate is uniformly spread. Initial rolling consists of one complete coverage with a 5 to 8 ton steel wheel roller followed by pneumatic tired rollers. Continue rolling until the aggregate is thoroughly keyed into the mat liquid asphalt. Use rollers that neither crush the aggregate excessively, nor pick up material. A combination steel wheel and pneumatic tired roller will not be permitted. Use two individual rollers.

At the beginning of each mat liquid asphalt application, spread a paper over the end of the previously completed mat coat and begin the asphalt application on the paper. After application, remove and dispose of the paper.

After the aggregate is thoroughly seated, broom all excess aggregate off of the surface of the mat coat as directed. Traffic may be permitted on the mat coat immediately after the rolling and brooming is complete.

Correct defects or damage to the mat coat prior to the application of seal coat or plant mix overlay.

The seal coat may be applied the same day the mat coat is placed provided the mat coat has been satisfactorily applied and rolled.

(B) Asphalt Seal Coat

Use the type of seal coat as required by the contract.

Test seal coat aggregates, have approved, and drained of free moisture prior to use.

Adjust the aggregate rates to provide a sufficient quantity of cover material to be spread over the surface of the seal coat preventing traffic damage, where it is necessary to permit traffic on sections of a completed seal coat.

Perform rolling immediately after the aggregate has been uniformly spread. Initial rolling will consist of one complete coverage with a 5 to 8 ton steel wheel roller after that pneumatic tired rollers shall be used. Continue rolling until the aggregate is thoroughly keyed into the liquid asphalt. A final coverage with the steel wheel roller may be required to provide a satisfactory finished surface. The use of rollers that

result in excessive crushing of the aggregate will not be permitted. Use rollers designed to prevent picking up the material. The use of a combination steel wheel and pneumatic tired roller will not be permitted. Use two individual rollers.

The requirements of Subarticle 660-9(A) will apply to the width of seal coat construction, application of liquid asphalt and aggregate, and the construction of joints. When directed, apply blotting sand in accordance with the requirements of Section 818.

The construction of the various types of seal coats will be in accordance with the following additional requirements:

(1) Straight Seal

Apply approximately 0.35-0.40 gallons square yard of asphalt material to the existing surface immediately followed by the application of 30-35 pounds per square yard (No. 78) or 16-19 pounds per square yard (Lightweight). Uniformly spread the full required amount of aggregate in one application and correct all non-uniform areas prior to rolling.

Immediately after the aggregate has been uniformly spread, perform rolling as previously described.

When directed, broom excess aggregate material from the surface of the seal coat.

(2) Split Seal

Apply approximately 0.20 to 0.30 gallons per square yard of asphalt material to the existing surface immediately followed by the application of approximately 20 to 22 pounds per square yard (No. 78) or 9-10 pounds per square yard (Lightweight) of seal coat aggregate spread uniformly over the treated surface.

Immediately after the first application of seal aggregate has been made uniform, apply the second application of the required amount of asphalt material and seal coat aggregate and roll the seal coat on each aggregate layer as previously described.

In lieu of the No. 78 or Lightweight stone, Blotting Material as defined in Article 1012-3 may be used for the top aggregate layer and the application rate should be approximately 6 to 12 pounds per square yard.

(3) Triple Seal

Apply approximately 0.20 to 0.25 gallons per square yard of the required liquid asphalt to the existing surface immediately followed by the application of approximately 15 to 20 pounds per square yard (No. 78) or 9 to 10 pounds per square yard (Lightweight) of the required amount of seal coat aggregate spread uniformly over the treated surface. Apply second and third layers and after the final application of each aggregate layer is applied, roll it as previously described.

In lieu of the No. 78 or Lightweight stone, Blotting Material as defined in Article 1012-3 may be used for the top aggregate layer and the application rate should be approximately 6 to 12 pounds per square yard.

(4) Slurry Seal

(a) Mix Requirements

Submit to the Engineer a mix design and results of the wear loss by the Wet Track Abrasion Test as prepared by an approved testing laboratory. The Wet Track Abrasion Test (WTAT) will be performed in accordance with ASTM D 3910. The wear loss by the Wet Track Abrasion Test must not be greater than 100 grams per square foot. Apply the wear loss to the asphalt content limits designated on the job mix formula.

Place a test strip for approval by the Engineer prior to beginning the work. Once the consistency of the mix has been approved by the Engineer, maintain the total water content within 3 percent of the approved blend during the course of operation.

Submit a mix design for each type slurry. The gradation of the mix produced must conform to the job mix range. The asphalt content (residual asphalt) must not vary by more than 1.5 percent from the approved mix design.

TABLE 660-2
Slurry Seal Gradation

Type	PERCENTAGE OF TOTAL BY WEIGHT PASSING (mm)											REMARKS
A	3/8"	#4	#8	#10	#16	#30	#40	#50	#80	#100	#200	
B	100	90-100	65-90		45-70	30-50		18-33		10-21	5-15	Design Asphalt Content, Percent #: 8.5-13
C	100	90-100	70-90		32-54	23-38		16-29		9-20	5-15	Design Asphalt Content, Percent #: 8.5-11.5

(b) Sampling Requirements

Samples for gradation will be taken from aggregate stockpiles designated by the Contractor for use. Take samples for asphalt content and total water content from the completed mixture. Samples of aggregate, filler, and emulsion for wet track abrasion check test will be taken at the job site. The frequency of sampling and testing will be established by the Engineer based upon the Department's current acceptance program and local conditions encountered.

(c) Equipment

Combine the mixing and spreading equipment in a single mobile operating unit. Attach a burlap drag approximately 19 inches wide to the back of the unit for the purpose of smoothing the slurry seal. Equip the mobile unit with an approved feeder that will accurately meter or otherwise introduce a predetermined amount of material into the mixer simultaneously with the aggregate. Use the feeder whenever mineral filler is added to the mix. Equip the mobile unit with a water pressure system and fog type spray bar capable of completely fogging the surface to that slurry seal is to be applied. Use a mobile unit capable of an operative speed of at least 60 feet per minute and that has sufficient storage capacity to mix and apply a minimum of five tons of slurry.

Mixer Use a continuous flow type mixer capable of delivering water and a predetermined proportion of aggregate and asphalt emulsion to a revolving multiblade mixer tank. Use a mixer that discharges the thoroughly mixed product on a continuous basis and in that the blades of the mixing unit are capable of thoroughly blending all ingredients.

Spreader Use a spreader equipped with a flexible type squeegee positioned in contact with the pavement surface and designed to apply a uniform spread with a minimum loss of slurry.

Auxiliary Equipment Provide hand squeegees, shovels, and other hand equipment as necessary to perform work in areas that are inaccessible to the unit.

(d) Construction Methods

Preparation of Surface Thoroughly clean the surface upon that slurry seal is to be applied of all loose material, vegetation, silt spots, and other objectionable materials immediately preceding application by either brooming or the use of compressed air.

Application Wet aggregate immediately prior to mixing with the emulsion. The Engineer may direct that the surface of the pavement be fogged with water (approximately 0.05 gallon per square yard) immediately preceding the pass of the spreader. Provide a slurry mixture of a consistency such that it rolls in the spreader box in a continuous mass. Slurry that segregates in the spreader box, so that

flowing of liquids (water and emulsion) is evident, is not acceptable and shall not be applied. The liquid portion of slurry mixture must not flow from either the spreader box or the applied slurry. Evidence of such flow is sufficient cause for rejection of the applied material. Place the slurry on the road in full lane widths up to and including 12 feet. Use a mechanical device such as an auger to distribute the slurry mix in the spreader box.

Correct excess buildup of slurry on longitudinal and transverse joints.

Do not open treated areas to traffic until such time as the slurry seal has cured to the extent that it will no longer be damaged by traffic. The applied slurry mixture must be uniform in texture and not flush under traffic. Correct any areas not considered satisfactory by the Engineer at no additional expense to the State. Nothing contained herein is intended to relieve the Contractor from sharing in the responsibility and performance of the treatments, should a failure occur prior to acceptance of the contract. Article 105-17 of the Specifications is amended accordingly.

Do not apply Slurry Seal surface course on surfaces containing ponding water and the minimum surface temperature must be 50°.

The Engineer may require the surface area to that the slurry has been applied by hand to be rolled using a pneumatic-tire type roller. Operate the roller at an approximate tire pressure of 50 psi and subject the paved area to a minimum of two coverages.

Should oversize aggregate be encountered in the stockpile, immediately cease operation and remove the oversize aggregate by screening.

Thickness of Application The average minimum thickness of application must be at least 3/16" for Type B and at least 5/16" for Type C unless otherwise specified.

In the event of a test failure on compatibility and/or WTAT (loss greater than 100 grams per square foot) for a sample of material being applied to the road, take corrective action prior to start-up of another day's run. Should the sample taken following adjustment also fail the compatibility and/or WTAT, cease application on the road. Maintain responsibility for furnishing additional compatibility and/or WTAT results and field application site(s) and will not be permitted to return to the road until he clearly demonstrates the acceptability of seal.

Materials placed in stockpiles or on the road not meeting the required tolerances may be accepted at a reduced price if it is not considered detrimental to the life of the treatment by the Engineer in accordance with Article 105-3. The following price adjustment schedule will be used when appropriate:

(i) One percent reduction in the bid price per square yard for each one-tenth percent the asphalt content is out of tolerance.

(ii) One-quarter percent price adjustment in the bid price per square yard for each one percent that the aggregate gradation is out of the job mix range.

(iii) One-half percent reduction in the bid price per square yard for each gram per square foot of WTAT loss between 101 and 200 grams. Material having a loss greater than 200 will not be accepted for payment.

(iv) One percent reduction in the bid price per square yard for each one percent water in excess of the approved water content plus three percent.

Price adjustments under 1, 2, 3, and 4 above shall apply concurrently; however, price adjustment will not apply in the event the material is rejected. The disposition of rejected material will be subject to the approval of the Engineer.

(C) Asphalt Mat and Seal

Construct the mat coat in accordance with Subarticle 660-9(A) using the size aggregate required by the contract.

Construct the seal coat in accordance with Subarticle 660-9(B) using the type seal required by the contract.

(D) Cape Seal

Construct the cape seal by applying a seal coat followed by applying a slurry seal as defined in Article 660-9(B).

660-10 MAINTENANCE AND PROTECTION

Maintain and protect the asphalt surface treatment until it is accepted by the Department. Make all necessary repairs in such a manner as to preserve the uniformity of the surface.

660-11 MEASUREMENT AND PAYMENT

Asphalt Surface Treatments will be measured and paid for at the contract unit price per square yard. These include *Asphalt Surface Treatment, Mat Coat, No. __ Stone, Asphalt Surface Treatment, ____ Seal, Asphalt Surface Treatment, Slurry Seal, Asphalt Surface Treatment, Cape Seal, or Asphalt Surface Treatment, Mat and Seal*. Payment at the above prices will be made for replacing any satisfactorily completed asphalt surface treatment when such replacement has been made necessary by defects in subgrade or base that has been constructed by others.

When the Engineer directs that the rate of application of asphalt material be decreased below the minimum rate shown in Table 660-1, no reduction in compensation will be made.

When the Engineer directs that the rate of application of asphalt material be increased above the maximum rate shown in Table 660-1, compensation to the Contractor will be made in the amount of 5 cents plus the verified cash cost to the Contractor at the point of

delivery for each gallon of asphalt material, measured at application temperature, necessitated by the increase.

Blotting sand will be paid for as provided in Article 818-5 for Blotting Sand.

Furnishing and applying prime will be paid for as provided in Article 600-10 for Prime C.

Payment will be made under:

Pay Item	Pay Unit
Asphalt Surface Treatment, Mat Coat, No. _____ Stone	Square Yard
Asphalt Surface Treatment, _____ Seal	Square Yard
Asphalt Surface Treatment, Mat and Seal	Square Yard

SECTION 661
ULTRA-THIN BONDED WEARING COURSE

661-1 DESCRIPTION

Produce and place an Ultra-thin Bonded Wearing Course (UBWC), including an application of a warm Polymer-Modified Emulsion Membrane (PMEM) followed immediately with an Ultra-thin Bonded Wearing Course hot mix asphalt overlay. Spray polymer-modified emulsion membrane immediately before applying hot mix asphalt

661-2 MATERIALS

Item	Section
Coarse Aggregate and Fine Aggregate	1005 and 1012
Mineral Filler	1012
Asphalt Binder, Grade 70-28	1020
Anti-strip Additive (Hydrated Lime)	1012-1(E)
Anti-strip Additive (Chemical)	1020-8

Do not use crystalline limestone, crystalline-dolomitic limestone, or marble for aggregates and do not use reclaimed asphalt pavement. Reclaimed asphalt shingle material may be used up to 6 percent by weight of total mix. Provide documentation that the asphalt binder grade meets the above requirements.

(A) Coarse Aggregate

Coarse aggregates, such as crushed gravel, limestone, dolomite, sandstone, granite, chert, traprock, ore tailings, slag, or other similar materials, or blends of two or more of the above may be acceptable. Proportion and blend coarse aggregates for these mixes if made from more than one source or of more than one type of material, to provide a uniform mixture. Use coarse aggregates typically used for high performance surfaces. Coarse aggregates shall meet the skid resistance criteria as set forth by the Department and have a history of successful use in surface mixes for the intended traffic level.

Coarse aggregate material retained above the No. 4 sieve shall be from approved sources and shall meet the requirements listed in Table 661-1.

TABLE 661-1 - COARSE AGGREGATE – PROPERTIES

Tests	Method	Limit
Los Angeles abrasion value, % loss	AASHTO T 96	35 max
Soundness, % loss, Sodium Sulfate	AASHTO T 104	15 max
Flat & Elongated Ratio, 5:1, + No 4	ASTM D 4791	10 % max
% Fractured Particles, single face	ASTM D 5821	100 min
% Fractured Particles, two or more mechanically crushed faces	ASTM D 5821	85 min
Micro-Deval, % loss	AASHTO TP 58-02	18 max

(B) Fine Aggregate

The fine aggregate passing the No. 4 sieve shall be from approved sources and shall meet the requirements of Table 661-2 below.

TABLE 661-2 - FINE AGGREGATE – PROPERTIES

Tests	Method	Limit
Sand Equivalent	AASHTO T 176	45 min
Uncompacted Void Content	AASHTO T 304 (Method A)	40 min

(C) Mineral Filler

Use hydrated lime, certain classes of fly ash, baghouse fines and Type 1 Portland Cement if needed as mineral filler.

(D) Polymer Modified Emulsion Membrane

Use Polymer Modified Emulsion Membrane consisting of styrene butadiene block co-polymer modified asphalt emulsion to form a water impermeable seal and bond the new hot mix to the existing surface. Complete polymer modification of base asphalt prior to emulsification.

Conform to the following:

TABLE 661-3 EMULSION AND RESIDUE TESTING	Method	Min.	Max
EMULSION			
Viscosity @ 77°F, SFS	AASHTO T 59	20	100
Sieve Test, %	AASHTO T 59		0.1
24-Hour Storage Stability, % (1)	AASHTO T 59		1
Residue from Distillation @ 400°F, % (2)	AASHTO T 59	63	
Oil portion from distillation ml of oil per 100 g emulsion			2
Demulsibility 35 ml, 0.02 N $CaCl_2$ or 35 ml, 0.8 % dioctyl sodium sulfosuccinate	AASHTO T 59	60	
RESIDUE			
Solubility in TCE, % (3)	AASHTO T 44	97.5	
Elastic Recovery, 50°F			
20 cm elongation % (4)	AASHTO T 301	60	
Penetration @ 77°F, 100 g, 5 sec, dmm	AASHTO T 49	60	150

(1) After standing undisturbed for 24 hours, the surface shall show no white, milky colored substance, but shall be a smooth homogeneous color throughout.

(2) AASHTO T-59 with modifications to include a 400°F ± 10°F maximum temperature to be held for a period of 15 minutes.

(3) ASTM D 5546, Test Method for Solubility of Polymer-Modified Asphalt Materials in 1,1,1-Trichloroethane may be substituted where polymers block the filter in Method D 2042.

(4) ASTM D 6084, Standard Test Method for Elastic Recovery of Binder Materials by Ductilometer with exception that the elongation is 20 cm and the test temperature is 50°F.

(E) Asphalt Binder For Plant Mix, Grade PG 70-28

Conform to the requirements of Section 620. The asphalt binder shall be compatible with the PMEM and existing pavement. Modify the binder with SBS, SB, or SBR polymer. Air blown asphalt is not permitted. Modification, testing, and certification of the asphalt binder shall be performed prior to delivery to the asphalt plant. Make test results available to the Engineer prior to use.

Meet the requirements of the following criteria

Test on Binder	**Method**		
Separation of Polymer, %	ASTM D5892	Report	10
Tests On Residue From RTFO Test			
Elastic Recovery, %	ASTM D 6084	Minimum	60

(F) Anti-Strip Additive

Use anti-strip additive and in accordance with the requirements of Article 620-3.

(G) Composition of Mix

Use a mixture of coarse and fine aggregate, asphalt binder, mineral filler, and other additives when required. Size, uniformly grade, and combine in such proportions such that the resulting mixture meets the gradation and physical requirements of Table 661-4. Use the mix design and optimum asphalt content for *Ultra-thin Bonded Wearing Course Mix Design Guidelines* on file with the Department's Materials & Tests Unit and available upon request.

Submit in writing a mix design and proposed job mix formula (JMF) targets for each required mix type and combination of aggregates to the Engineer for review and approval at least 10 days prior to start of asphalt mix production. Submit the mix design and proposed job mix formula targets on forms and in a format approved by the Department and in accordance with applicable requirements of Article 610-3.

Establish the job mix formula target values within the mix design criteria specified in Table 661-4 for the particular type mixture.

Have on hand at the asphalt plant, the approved mix design and job mix formula issued by the Department, prior to beginning the work.

The job mix formula for each mixture shall remain in effect until modified in writing by the Engineer, provided the results of QMS tests performed on material currently being produced conform with specification requirements. Should a change in sources of aggregate materials be made, a new mix design and job mix formula will be required before the new mixture is produced. When unsatisfactory results or other conditions make it necessary, the Engineer may establish a new job mix formula.

Determine and certify compatibility of all asphalt emulsion, asphalt binder, and aggregate components.

TABLE 661-4 – MIXTURE DESIGN CRITERIA				
Gradation Design Criteria (% Passing by Weight)				
Standard Sieves		**1/2 in. Type A**	**3/8 in. Type B**	**1/4 in. Type C**
ASTM	**Mm**	**(% Passing by Weight)**		
¾ inch	19.0	100		
½ inch	12.5	85 - 100	100	
3/8 inch	9.5	60 - 80	85 - 100	100
#4	4.75	28 - 38	28 - 42	40 - 55
#8	2.36	19 - 32	19 - 32	22 - 32
#16	1.18	15 - 23	15 - 23	15 - 25
#30	0.600	10 - 18	10 - 18	10 - 18
#50	0.300	8 - 13	8 - 13	8 - 13
#100	0.150	6 - 10	6 - 10	6 - 10
#200	0.075	4.0 - 7.0	4.0 - 7.0	4.0 - 7.0
Mix Design Criteria				
Asphalt Content, %		4.6 - 5.6	4.6 - 5.8	5.0 – 5.8
Draindown Test, AASHTO T 305		0.1% max		
Moisture Sensitivity, AASHTO T 283*		80% min		
Application Rate, lb/ yd^2		90	70	50
Approximate Application Depth, in.		3/4	5/8	1/2
Asphalt PG Grade, AASHTO M 320		PG 70-28	PG 70-28	PG 70-28

NOTE: *Specimens for T-283 testing are to be compacted using the SUPERPAVE gyratory compactor. The mixtures are to be compacted using 100 gyrations to achieve specimens approximately 95 mm in height. Mixture and compaction temperatures as recommended by the binder supplier.

661-3 CONSTRUCTION

(A) Equipment

Furnish paving machine with the following capabilities:

(1) Self-priming paving machine capable of spraying the Polymer-Modified Emulsion Membrane, applying the hot asphalt concrete overlay and screeding the surface of the mat to the required profile and cross- section in one pass at any rate between 30 to 92 ft/minute.

(2) Receiving hopper, feed conveyor, storage tank for Polymer-Modified Emulsion Membrane material, PMEM emulsion single variable-width spray bar and a variable width, heated, vibratory-tamping bar screed.

(3) Screed with the ability to be crowned at the center both positively and negatively and have vertically and horizontally adjustable extensions to accommodate the desired pavement profile and widths.

(4) Sprayer system capable of accurately and continuously monitoring the rate of spray and providing a uniform application across the entire width to be overlaid.

(5) Use pavers equipped with an electronic screed control that will automatically control the longitudinal profile and cross slope of the pavement. Control the longitudinal profile through the use of either a mobile grade reference(s), including mechanical, sonic and laser grade sensing and averaging devices, an erected string line(s) when specified, joint matching shoe(s), slope control devices or the approved methods or combination of methods. Unless otherwise specified, use a mobile grade reference system capable of averaging the existing grade or pavement profile over a minimum 30 foot distance or by non-contacting laser or sonar type ski with at least four referencing stations mounted on the paver at a minimum length of 24 feet. Establish the position of the reference system such that the average profile grade is established at the approximate midpoint of the system. The transverse cross-slope shall be controlled as directed by the Engineer.

Use an erected fixed stringline for both and longitudinal profile and cross slope control when required by the contract. When an erected fixed string line is required, furnish and erect the necessary guide line for the equipment. Support the stringline with grade stakes placed at maximum intervals of 25 feet for the finished pavement grade.

Use the 30 foot minimum length mobile grade reference system or the non-contacting laser or sonar type ski with at least four referencing stations mounted on the paver at a minimum length of 24 feet to control the longitudinal profile when placing the initial lanes and all adjacent lanes of all layers, including resurfacing and asphalt in-lays, unless other specified or approved. A joint matching device (short 6 inch shoes) may be used only when approved.

Utilize the automatic slope control system unless otherwise approved. The Engineer may waive the use of automatic slope controls in areas where the existing surface (subgrade, base, asphalt layer, etc.) exhibits the desired cross slope of the final surface. The Engineer may also waive the use of automatic slope controls in areas where the use of such equipment is impractical due to irregular shape or cross section (such as resurfacing). When the use of the automatic slope controls is waived, the Engineer may require the use of mobile grade references on either or both sides of the paver. Manual screed operation will be permitted in the construction of irregularly shaped and minor areas, subject to approval. Waiver of the use of automatic screed controls does not relieve the Contractor of achieving plan profile grades and cross-slopes.

In the case of malfunction of the automatic screed control equipment, the paver may be manually operated for the remainder of the workday provided this

method of operation produces acceptable results. Do not resume work thereafter until the automatic system is functional.

The Engineer will waive the requirement for use of pavers for spreading and finishing where irregularities or obstacles make their use impractical. Spread, rake, and lute the mixture by hand methods or other approved methods in these areas.

Operate the paver as continuously as possible. Pave intersections, auxiliary lanes, and other irregular areas after the main line roadway has been paved, unless otherwise approved.

Compact the wearing course with a steel double drum asphalt roller(s) with a minimum weight of 10 tons. Maintain rollers in reliable operating condition and equip with functioning water system and scrapers to prevent adhesion of the fresh mix onto the roller drums. Supply adequate roller units and compact promptly following the placement of the material.

Request approval of equipment prior to the start of any work. Maintain all equipment and tools in satisfactory working condition at all times.

(B) Surface Preparation

Perform the following items prior to the commencement of paving operations.

(1) Protect and cover manhole covers, drains, grates catch basins and other such utility structures with plastic or building felt prior to paving and reference for location and adjustment after paving.

(2) Remove thermoplastic traffic markings symbols, characters, or other markings greater than ¼ inch in thickness on the existing pavement.

(3) Clean and completely fill pavement cracks and joints greater than ¼ inch wide. Do not overband the existing cracks and joints. Apply sealant per manufacturer's recommendation.

(4) Fill surface irregularities greater than 1" deep with a material approved by the Engineer.

(5) Thoroughly clean the entire pavement surface, giving specific attention to accumulated mud and debris. Pressurized water and/or vacuum systems may be required to ensure a clean surface.

(C) Application of Ultra-thin Bonded Wearing Course

Do not place Ultra-thin Bonded Wearing Course between October 31 and April 1, when the pavement surface temperature is less than 50°F or on a wet pavement. A damp pavement surface is acceptable for placement if it is free of standing water and favorable weather conditions are imminent.

Apply the Ultra-thin Bonded Wearing Course mixture at the rate per square yard as shown in Table 661-4 for the mix type shown in the plans.

Spray the Polymer-Modified Emulsion Membrane at a temperature of 140 - 180°F. Provide a uniform application across the entire width. Determine the rate of application (typically 0.15 to 0.25 gal/yd2) by the mix design and current pavement condition for the specified project. Have the rate of application approved by the Engineer prior to beginning work.

Do not allow wheels or other parts of the paving machine to touch the Polymer-Modified Emulsion Membrane before the hot mix asphalt concrete wearing course is applied.

Place the hot asphalt concrete wearing course over the full width of the polymer-modified emulsion membrane. Apply the hot mix asphalt concrete at a temperature of 300 - 330°F and within a maximum of 3 seconds immediately after the application of the membrane. The temperature of the mix at the asphalt plant shall be within ±15°F of the JMF temperature. The temperature of the mix immediately prior to discharge from the hauling vehicle shall be within +15°F to -25°F of the JMF temperature.

Before opening to traffic, allow the pavement to sufficiently cool after the rolling operation to resist damage to the pavement.

(D) Compaction

Compact the wearing course with at least two passes of a steel double drum asphalt roller before the material temperature has fallen below 185°F. Do not allow the rollers to remain stationary on the freshly placed asphalt concrete. Compact immediately following the placement of Ultra-thin Bonded Wearing Course. A release agent (added to the water system) may be required to prevent adhesion of the fresh mix to the roller drum and wheels. Compact in the static mode.

QUALITY MANAGEMENT SYSTEM FOR ASPHALT PAVEMENTS

Produce the Ultra-thin Hot Mix Asphalt in accordance with the applicable provisions of Section 609 of the contract documents.

661-4 MEASUREMENT AND PAYMENT

Ultra-thin Hot Mix Asphalt, Type_____ will be measured and paid for by the actual number of tons of mixture that has been incorporated into the completed and accepted work. The hot mix asphalt pavement will be measured by being weighed in trucks on certified platform scales or other certified weighing devices.

Ultra-thin Hot Mix Asphalt will be measured and paid for at the contract unit price per square yard. In measuring this quantity, the length will be the actual length constructed, measured along the surface. The width will be the width required by the contract or directed by the Engineer.

Asphalt Binder For Plant Mix, Grade PG 70-28 will be paid for in accordance with Section 620-4. Asphalt binder price adjustments when applicable will be based on Grade PG 64-22, regardless of the grade used.

The above prices and payments shall include but not be limited to all traffic control, labor, materials, including the polymer modified asphalt emulsion, equipment necessary to

produce and deliver the mix, including anti-strip additive (if necessary), equipment necessary to apply and compact the mix, and maintaining the Ultra-thin bonded wearing course until final acceptance of the project.

Providing QMS for asphalt pavements will be in accordance with the contract documents included elsewhere in this proposal.

Payment will be made under:

Pay Item	Pay Unit
Ultra-thin Hot Mix Asphalt, Type A	Ton
Ultra-thin Hot Mix Asphalt, Type B	Ton
Ultra-thin Hot Mix Asphalt, Type C	Ton
Application of Ultrathin Hot Mix Asphalt	Square Yard

SECTION 663
HOT IN-PLACE RECYCLED ASPHALT CONCRETE

663-1 DESCRIPTION

This work shall consist of hot in-place recycling of the existing asphalt concrete surface by heating and softening the existing asphalt pavement with indirect heat, loosening the heated pavement by hot milling to the depth specified in the plans, adding a plant produced hot mix asphalt admixture, if required, applying a rejuvenating agent, thoroughly remixing the material in a pugmill, leveling, relaying and compaction of the hot-in-place recycled (HIR) asphalt mixture. Use a continuous, single train, single pass, multi-step process to accomplish this work.

Hot In-Place Recycled Asphalt Concrete production and placement, including all materials and equipment shall be in accordance with applicable provisions of Division 6 except as specifically noted or modified herein.

Provide and conduct the quality control and required testing for acceptance of the HIR mixture in accordance with Quality Management System For Asphalt Pavements (Hot In-Place Recycled Asphalt), included herein.

663-2 MATERIALS

(A) Hot Mix Asphalt Admixture

Determine the type and amount of plant produced hot mix asphalt (HMA) admixture to be added to the recycled mixture, subject to the approval of the Engineer. The HMA admixture shall be a plant mixture of asphalt binder and aggregate(s) meeting the applicable requirements of Division 10 as shown below. The aggregate in the admixture may be a single standard size aggregate or a combination of aggregate sizes as needed. Provide enough binder content for the admixture such that the aggregate particles are fully coated. Provide a gradation and binder content for the admixture such that when blended with the other mix components, the hot in-place recycled mix properties will meet the mix design criteria for the applicable mix type

specified in the plans, unless otherwise approved by the Engineer. Produce the HMA admixture in accordance with applicable requirements of Division 6.

Coarse Aggregate	Article 1012-1
Fine Aggregate	Article 1012-1
Stone Screenings	Article 1012-1
Asphalt Binder	Article 1020-2
Anti-strip Additive	Article 1020-8

(B) Asphalt Rejuvenating Agent

Use an asphalt rejuvenating agent meeting the following requirements

	Minimum	Maximum
Viscosity, 77^{o} F, SFS, ASTM D-244	20	125
Sieve, %, ASTM D-244	------	0.10
Storage Stability, 24 hr, %, ASTM D-244	------	1
Residue from distillation, % (1)	60	------
Oil Distillate, Volume %	------	5
Tests on Residue and Rolling Thin-film Oven Tests: (2)		
Penetration @ 77o F, 5 sec.	300	------
Torsional Recovery 39.7o F, %	20	------

Notes (1) ASTM D244 except that the maximum temperature shall be 350^{o}F held for 20 minutes.

(2) The residue from distillation shall be subject to the standard rolling thin film oven test.

663-3 COMPOSITION OF MIXTURE (Mix Design /Job Mix Formula)

(A) Mix Design-General

Prepare and submit a proposed HIR mix design and job mix formula to the Engineer at least 14 days prior to beginning work in accordance with all applicable requirements of Article 610-3 except as modified herein. In addition, submit a proposed mix design for the admixture if an admixture is required.

Sample the existing pavement by coring or other methods approved by the Engineer to determine representative characteristics and properties of the existing pavement for use in mix design preparation. Take these samples at a minimum of one sample every 2000 linear feet of each lane. Provide samples for quality assurance testing when requested by the Engineer. Take these all samples in the presence of the Engineer and at locations approved by the Engineer.

Perform and document a mix design in accordance with the Department's most current accepted policies and procedures for the design of asphalt mixes. The

Department's Asphalt Design Engineer at the Materials and Tests Unit may be contacted for copies of these procedures. Establish the proposed HIR mix design such that the hot in-place recycled mix properties are within the design criteria for the type mix specified, unless otherwise approved by the Engineer. Submit the mix designs on forms and in the format approved by the Department. Once the proposed mix designs are approved, the Engineer will provide approved Job Mix Formulas.

In addition to applicable mix design data required in Sub-article 610-3 (A), the data shall include but not be limited to the proposed percent admixture, if needed, admixture components, gradation, binder grade, binder content, percent anti-strip additive in admixture, percent existing pavement (RAP), gradation and binder content of existing pavement, percent rejuvenating agent, penetration of recovered binder from total mix, and all mix design properties and calculations.

(B) Mix Design Criteria

The finished asphalt pavement shall be a uniform mixture composed of the existing in-place asphalt pavement, asphalt rejuvenating agent, and new hot mix asphalt admixture, if required. The hot in-place recycled asphalt mix shall meet applicable requirements of Section 610-3 (excluding maximum percentage of allowable RAP) for the mix type specified, except as modified herein.

The proposed HIR mix design shall be established such that the hot in-place recycled mix properties will meet applicable gradation and mix design requirements of Table 663-1 and Table 663- 2 for the mix type specified, except as modified herein, unless otherwise approved by the Engineer

Add an asphalt rejuvenating agent at a rate that yields a completed mixture with a minimum/maximum penetration value as specified in Table 663-2 below, unless otherwise approved by the Engineer.

TABLE 663-1 AGGREGATE GRADATION DESIGN CRITERIA

Standard	Percent Passing Criteria (Control Points)					
Sieves	Mix Type (Nominal Maximum Aggregate Size)					
	9.5 mm		12.5 mm		19.0 mm	
(mm)	Min.	Max.	Min.	Max.	Min.	Max.
50.0						
37.5						
25.0					100.0	
19.0			100.0		90.0	100.0
12.5	100.0		90.0	100.0		90.0
9.5	90.0	100.0		90.0		
4.75		90.0				
2.36**	32.0**	67.0**	28.0	58.0	23.0	49.0
1.18						
0.600						
0.300						
0.150						
0.075	4.0	8.0	4.0	8.0	3.0	8.0

**NOTE: For Type SF 9.5A the percentage Passing the 2.36 mm sieve is 60% Minimum and a Maximum of 70%.
Aggregate Nominal Maximum Size is defined as one standard sieve size larger than the first sieve to retain more than 10 percent aggregate. Maximum Size is defined as one standard sieve size larger than the nominal maximum size.

Table 663-2 MIX DESIGN CRITERIA

Mix Type	Design ESALs (millions) (a)	Target Binder PG Grade	Compaction Levels No. Gyrations @ N_{ini}	N_{des}	N_{max}	Volumetric Properties (b) (AASHTO PP 28) VMA % Min.	VTM %	VFA Min.-Max.	%Gmm @ N_{ini}
SF-9.5A	< 0.3	64 - 22	6	50	75	16.0	3.0 - 5.0	70 - 80	≤ 91.5
S-9.5A	< 0.3	64 - 22	6	50	75	15.0	3.0 - 5.0	70 - 80	≤ 91.5
S-9.5B	0.3 - 3	64 - 22	7	75	115	15.0	3.0 - 5.0	65 - 80	≤ 90.5
S-9.5C	3 - 30	70 - 22	8	100	160	15.0	3.0 - 5.0	65 - 76	≤ 89.0
S-12.5B	< 3	64 - 22	7	75	115	14.0	3.0 - 5.0	65 - 78	≤ 90.5
S-12.5C	3 - 30	70 - 22	8	100	160	14.0	3.0 - 5.0	65 - 75	≤ 89.0
I-19.0B	< 3	64 - 22	7	75	115	13.0	3.0 - 5.0	65 - 78	≤90.5
I-19.0C	3 - 30	64 - 22	8	100	160	13.0	3.0 - 5.0	65 - 75	≤ 89.0
	Design Parameter					**Design Criteria**			
All Mix	1. $\%G_{mm}$ @ N_{max}					≤ 98.0% (c)			
	2. Penetration(AASHTO T 49) from Abson Recovery (AASHTO T 170)					40 Min. 90 Max.			

Notes: (a) Based on 20 year design traffic.
(b) Volumetric Properties based on specimens compacted to Ndes as modified by the Department.
(c) Based on specimens compacted to Nmax at selected optimum asphalt content.
(d) Mix Design Criteria may be modified, subject to approval by the Engineer.

(C) Job Mix Formula

Once the proposed mix design is approved, the Engineer will provide a Job Mix Formula for the hot in-place recycled asphalt mix. The job mix formula will be established within the design criteria in Tables 663-1 and 663-2, unless otherwise approved by the Engineer.

Once the HIR mix design is approved, the Engineer will provide a Job Mix Formula for the admixture if admixture is required. The completed admixture shall be produced in accordance with the Job Mix Formula requirements for gradation and binder content as prescribed in Quality Management System for Asphalt Pavements (Hot In-Place Recycled Asphalt Concrete – Superpave Version) as shown in the contract.

Samples of the completed recycled mixture may be taken by the Department on a random basis to determine if the PG grading on the recovered asphalt binder is in accordance with AASHTO M 320 for the grade specified. If the grading is determined to be a value other than required for the specified mix type, the Engineer may require the Contractor to adjust the grade and/or percentage of additional asphalt binder, asphalt rejuvenator, and/or the blend of reclaimed material and admixture to bring the PG grade to the specified value for the required mix type, in accordance with Table 663-2.

663-4 EQUIPMENT

(A) General

Equipment used to recycle the existing asphalt surface shall be designed and built for this specific purpose. The equipment shall be capable of a single pass, multi-step operation that includes; multi-step heating, milling, introducing rejuvenating agent, introducing hot mix asphalt admixture, if required, mixing the new material with the reclaimed material in a separate on-board chamber, redistributing the recycled material, leveling, and compacting the mixture.

(B) Heating Unit

Preheating mechanism(s) consisting of clusters of heaters capable of uniformly heating the asphalt pavement to a temperature high enough to remove excess moisture, to allow milling of the existing pavement material to the designated plan depth without excessive fracturing of aggregate particles, without charring the existing asphalt and without producing undesirable pollutants. The heating mechanism shall be so equipped that the heat application shall be completely under an enclosed or shielded hood. The unit shall be adjustable in width. The Contractor shall protect adjacent landscape from heat damage and shall be responsible for any damage that may occur.

(C) Milling/Blending Unit

A self propelled processing unit containing the following:

(1) A recycling machine equipped with additional heaters conforming to the same requirements as the preheaters.

(2) A unit capable of uniformly loosening the existing asphalt pavement to the depth specified. Care must be taken to ensure that milling or pavement reclaiming does not degrade the aggregates but only loosens the heated existing pavement.

(3) A controlled system for adding and uniformly blending a rejuvenating agent at a predetermined rate with the reclaimed mix during the remixing and leveling operation. The metering equipment shall be capable of measuring in gallons. The application rate in gallons, for the added material, shall be synchronized with the machine ground speed to provide a uniform application. The actual rate used may be adjusted as determined

(4) A blending unit consisting of a twin shafted pugmill capable of uniformly adding new hot mix asphalt admixture, if required, at a rate established by the mix design. The unit shall be capable of thoroughly mixing the loosened asphalt pavement, asphalt rejuvenating agent, and new hot mix asphalt admixture if required, at the pugmill to produce a uniform mixture.

(5) A unit capable of auguring the heated and loosened material into a windrow at the center of the machine prior to entry into the blending unit.

(6) A paving machine meeting the requirements of Article 610-8 of the Standard Specifications, except as modified herein, shall be utilized to redistribute the remixed material over the width being processed and finished, so as to produce a uniform cross section and surface. The paving machine must be capable of screeding the full width of the remixed material. Automatic screed controls meeting the requirements of this Article shall be provided and used unless otherwise approved by the Engineer.

(7) The recycling train shall be capable of maintaining an average production rate of a minimum of 1 lane mile per day.

(8) The reheating and remixing units shall meet all state and local air quality emission standards for mobile sources.

(D) Compaction Equipment

Rollers meeting the requirements of Section 610-9 of the Standard Specifications and capable of achieving the specified density and surface requirements shall be utilized.

663-5 CONSTRUCTION REQUIREMENTS

Hot In-place recycled mixtures shall not be produced or placed during rainy weather or when the air temperature measured in the shade away from artificial heat at the location of the paving operations is less than 50oF. Do not place surface course material that is to be the final layer of pavement between December 15 and March 16 of the next year.

Prior to heating and remixing operations, the pavement shall be cleaned of all loose material. Power brooms shall be used and supplemented when necessary by hand brooming or other cleaning operations, as required, to bring the surface to a clean, suitable condition free of deleterious material.

The pavement surface shall be evenly heated, loosened, and remixed to the lines, grades and depths shown on the plans. Heating shall be controlled to ensure uniform heat penetration without overheating, cooking, or sooting of the asphalt pavement. The milled material shall be picked up, mixed with an asphalt rejuvenator and asphalt admixture, if needed, in a pugmill and then distributed and leveled by a conventional paving machine. The temperature of the milled material shall not be more than 325oF when measured immediately behind the milling unit. The temperature of the remixed material shall not be less than 235^{o}F directly behind the screed.

The heating operation shall extend at least 4 inches beyond the width of remixing on both sides. When a pass is made adjacent to a previously placed mat, the longitudinal joint shall extend at least 2” into the previously placed mat.

The layer thickness of the HIR specified in the Plans or Contract Proposal shall be the compacted in-place thickness of the rejuvenated recycled mixture layer including any admixture. The depth of milling of the existing surface shall be such that the depth as specified on the plans is within ±1/4 inch, unless otherwise approved by the Engineer.

The asphalt rejuvenator shall be applied uniformly to the mixed material prior to remixing in the pugmill. The rate of application of rejuvenator will be as specified on the Job Mix Formula approved by the Engineer based upon the Contractor's proposed mix design.

The remixed asphalt pavement shall be compacted immediately after it has been spread and leveled, while it is still in a workable condition.

Density control may be by either core samples or nuclear density control in accordance with the Department's most current procedures. Density for HIR mixes shall be a minimum of 92.0 percent of Maximum Specific Gravity (Gmm), except for SF9.5A that will be 90.0 percent of the Maximum Specific Gravity (Gmm). The Maximum Specific Gravity (AASHTO T 209) will be determined by procedures specified in the Department's most current edition of the HMA/QMS Manual.

The compacted surface of the completed and accepted pavement structure shall meet the requirements of Article 610-12 of the Standard Specifications.

The Contractor shall take precautions needed to protect the adjacent landscape from heat damage. Damaged landscape shall be repaired or replaced at no cost to the Department.

663-6 MEASUREMENT AND PAYMENT

Hot In-Place Recycled Asphalt Concrete, Type___ will be measured and paid for by the square yard in the completed and accepted work.

Emulsified Asphalt Rejuvenating Agent to be paid for will be measured by the metered quantity in gallons used in all completed and accepted work and will be paid for at the contract price per gallon.

Hot Mix Asphalt Admixture will be measured and paid for, when required, will be measured by being weighed in trucks on a certified weighing device and documented on load tickets and will be paid for at the contract unit price per ton.

Asphalt binder to be paid for will be measured and paid for in accordance with Article 620.

The above prices and payments will be full compensation for all work covered by this section including but not limited to furnishing all materials, producing, weighing, transporting, placing, and compacting the recycled pavement; maintaining the finished course until final acceptance of the project, performing quality control as specified in the contract and making any repairs or corrections to the surface of the pavement that may become necessary.

Payment will be made under:

Pay Item	Pay Unit
Hot In-Place Recycled Asphalt Concrete, Type _____	Square Yard
Emulsified Asphalt Rejuvenating Agent	Gallon
Hot Mix Asphalt Admixture	Ton

SECTION 665
MILLED RUMBLE STRIPS ON ASPHALT CONCRETE SHOULDERS

665-1 DESCRIPTION

Construct rumble strips on asphalt concrete shoulders in accordance with the plans and as directed by the Engineer. Work includes but is not limited to furnishing all labor and equipment; disposing of milled material; and all incidentals necessary to complete the work satisfactorily.

665-2 EQUIPMENT

Provide equipment consisting of a rotary type cutting head with a maximum outside diameter of 24 inches and that is a minimum of 16 inches long. Provide a cutting head that has the cutting tips arranged in such a pattern as to provide a relatively smooth cut as well as a cutting head(s) that is on its own independent suspension from that of the power unit to allow the tool to self align with the slope of the shoulder and/or any irregularities in the shoulder surface.

Provide a cutting tool equipped with guides to provide consistent alignment of each cut in relation to the roadway and to provide uniformity and consistency throughout the project.

665-3 CONSTRUCTION METHODS

Demonstrate the ability to achieve desired surface inside each depression without tearing or snagging the asphalt prior to beginning the work.

Provide rumble strips that have finished dimensions of seven inches (±1/2 inch) wide in the direction of travel and are at least 16 inches long measured perpendicular to the direction of travel. Provide rumble strips having depressions with a concave circular shape with a minimum 1/2 inch depth at center (no more than an allowable depth 5/8 inch). Place rumble strips in relation to the roadway according to the patterns shown in the plans.

Material resulting from the operation becomes the property of the Contractor. Remove and dispose of this material in accordance with the requirements of Section 802.

At the end of each working day remove all equipment to a location where it does not present a traffic hazard, clean pavement and reopen work area to traffic.

665-4 MEASUREMENT AND PAYMENT

Milled Rumble Strips (Asphalt Cement Concrete) will be measured and paid for at the contract unit price per linear foot for the actual number of linear feet of shoulder, measured longitudinally along the surface of each shoulder, where rumble strips have been constructed.

Payment will be made under:

Pay Item	Pay Unit
Milled Rumble Strips (Asphalt Cement Concrete)	Linear Foot

DIVISION 7
CONCRETE PAVEMENTS AND SHOULDERS

SECTION 700
GENERAL REQUIREMENTS FOR PORTLAND CEMENT CONCRETE PAVING

700-1 DESCRIPTION

Perform the work covered by this section, which includes but is not limited to the construction of a single course non-reinforced portland cement concrete pavement on a prepared base, in accordance with these Specifications and with the lines, grades, thickness, and typical sections shown on the plans or as directed.

The Department accepts concrete paving with respect to strength, thickness, and ride quality on a lot by lot basis subject to adjusted unit prices as provided in Sections 710 and 720.

Use any combination of equipment that will effectively perform the necessary construction operations. Have the equipment at the job site sufficiently ahead of the start of construction operations for the Engineer to examine thoroughly and approve.

Maintain all equipment in a satisfactory operating condition while in use on the work.

Prior to placing concrete pavement, submit for approval a Process Control Plan addressing all operations necessary in the production, and placement of concrete pavement.

700-2 CONCRETE PRODUCTION EQUIPMENT

Use batch plants, central mix plants, and truck mixers that meet the requirements of Section 1000.

700-3 CONCRETE HAULING EQUIPMENT

Transport concrete to the point of placement either in a truck agitator, a truck mixer operating at agitating speed, or in non-agitating equipment meeting the provisions below. Bottom or belly dump equipment is prohibited. Provide and secure material covers on the equipment bodies for protection against detrimental environmental conditions.

Prevent the accumulation of hardened concrete in the delivery vehicles. Discharge all flushing water before charging with the next concrete load.

When using non-agitating hauling equipment, provide bodies which are smooth, watertight, metal containers with rounded internal corners equipped with vibrators and gates to discharge the concrete without segregation or damage.

For concrete hauled in a truck agitator or truck mixer, use Table 1000-2 to determine the maximum elapsed time for placement of concrete. For concrete hauled in non-agitating equipment, minimize the elapsed time to be 30 minutes or less, unless otherwise approved. The elapsed time is defined as the period from first contact between mixing water and cement until the entire operation of placing and finishing, including corrective measures if necessary, has been completed.

Deliver the concrete to the work site in a thoroughly mixed and uniform mass.

If at discharge, the concrete is not thoroughly mixed and homogeneous, the hauling distance, charging sequence, size of load, mixing time or any combination thereof should be altered to meet these requirements; otherwise, utilize other equipment capable of delivering a thoroughly mixed and uniform concrete mass.

700-4 PREPARATION OF SUBGRADE AND BASE

Prepare the subgrade and base beneath Portland cement concrete pavement in accordance with the applicable sections of these Specifications. Use approved automatically controlled grading and paving equipment to produce final subgrade and base surfaces meeting the lines, grades, and cross sections required by the plans or as directed. When in the judgment of the Engineer the use of such equipment is impractical, this requirement will be waived.

Dampen the surface of the base at the time the concrete is placed. Sprinkle the base when necessary to provide a damp surface. Ensure that no free water or ponding is present at the time of concrete placement. Correct all damaged areas in the subgrade or base prior to placing concrete.

Do not allow traffic on the underlying asphalt courses other than necessary local traffic and that developing from the operation of essential construction equipment as may be authorized by the Engineer. Repair any defects that develop in the underlying asphalt courses or any damage caused by local or construction traffic at no cost to the Department.

Unless otherwise approved, utilize and maintain a braided metal cable stringline reference to be used to control the profile and alignment of the concrete pavement. Monitor the stringline for accuracy and tautness. Set pins at a maximum distance of 50ft apart. When located on a vertical curve, set pins at a maximum distance of 25ft.

700-5 PLACING CONCRETE

(A) General

Use a slip form paver to place concrete except where impractical due to irregular areas or areas of existing pavement adjacent to the proposed pavement.

Place concrete only in the presence of the Engineer or his authorized representative.

Handle concrete in such a manner as to prevent segregation and keep free from mud, soil, or any other foreign matter.

Where finishing operations must be completed after dark, provide acceptable artificial light in accordance with Section 1413.

Do not begin paving operations or discontinue paving operations when any of the following conditions exist.

(1) When a descending air temperature in the shade and away from artificial heat reaches 35°F, stop paving. Do not resume paving until an ascending air temperature in the shade and away from artificial heat reaches 35°F.

(2) When the subgrade or base course is frozen.

(3) When aggregates to be used in the mix contain frozen particles.

(4) When air temperature in shade is 90°F and rising or the concrete temperature is greater than 95°F.

Where additional pavement must be placed adjacent to new pavement by machine methods, do not place it until the concrete has attained a flexural strength of at least 600 psi.

Construction equipment or hauling equipment will not be allowed over the pavement until the concrete has attained a flexural strength of 600 psi.

Spread the concrete uniformly over the entire area without segregation. Perform the spreading with a mechanical spreader independent of the paver except where hand methods are necessary due to pavement design, equipment breakdown, or other emergencies.

(B) Slip Form Paver Method

Use a slip form paver that is an approved self-propelled machine(s) designed to spread, consolidate, screed, and float finish the concrete in one complete pass of the machine in such a manner that requires a minimum of hand finishing to provide a smooth, dense, and homogeneous pavement. Use a slip form paver equipped with forms of sufficient length and rigidity to support the edges of the slab so as to minimize hand finishing. Use slip form pavers equipped with both horizontal and vertical automatic controls.

Operate the paver with continuous forward movement and coordinate all operations of mixing, delivering, and spreading the concrete to provide uniform progress and minimize stopping and starting of the paver.

Provide concrete that has sufficient cohesion to prevent appreciable slumping of the pavement edges. Longitudinal straight edge tolerance of 1/4" in 10 feet will apply to the area within 6" of the edge of pavement. Edge slump is limited to no more than 1/4".

(C) Fixed Form Method

Apply the requirements of this section to all paving operations where a slip form paver is not being used.

Use forms made of metal and of such section and design that they will adequately support the concrete and the construction equipment.

Use forms that have a depth not less than the edge thickness of the pavement to be constructed and not more than 1" greater than the edge thickness of the pavement to be constructed. Use a form which has the base width at least equal to the height of the form.

Use a form in which the top face does not vary from a true plane more than 1/8" in 10 feet and the upstanding leg does not vary more than 1/4".

Use straight forms that have at least 3 pin pockets per 10 feet in length and at least 2 pin pockets per 5 feet in length.

Use form pins that are metal and capable of holding the forms rigidly in place during construction operations. The Engineer may require pinholes in the base to be sealed prior to placing subsequent pavement.

Connect the form sections by a locking joint that will keep the forms free from vertical and horizontal movement.

Use straight forms 10 feet in length on tangents and on curves having a radius of 200 feet or more. For curves having a radius of between 200 feet and 50 feet use either straight forms 5 feet in length or flexible forms. Use flexible forms for curves having a radius of less than 50 feet.

Clean all forms before they are set and oil all forms before placing concrete. Check the bearing of the forms and correct all areas of inadequate bearing.

Remove all rejected forms immediately from the project.

Set forms a sufficient distance in advance of the point where the concrete is being placed to provide for a continuous operation in placing the concrete and for proper inspection of line and grade.

All forms used for construction joints shall meet the requirements of this section except that provisions shall be made for inserting dowel bars where required.

700-6 VIBRATING CONCRETE

Uniformly vibrate the concrete after it has been spread. Consolidated the full width and depth of the Portland cement concrete in a single pass.

Vibrators for full width vibration of concrete paving slabs may be either the surface pan type or the internal type with either immersed tube or multiple spuds. Attach the vibrators to the spreader or the finishing machine, or mount the vibrators on a separate carriage.

Furnish an electronic vibrator monitoring device, displaying the operating frequency of each individual vibrator on the paving equipment. Operate the electronic vibrator monitoring device in areas where the mainline, ramp, or loop pavement exceeds 600 feet in length. Record the time, station location, paver track speed, and operating frequency of each individual vibrators after every 25 feet of paving or after each 5 minute time interval has elapsed. Provide a report of the vibrator data to the Engineer daily for the first 3 days of paving and weekly thereafter. The Engineer may determine that more frequent submissions are necessary, particularly if equipment is malfunctioning.

Set the internal vibrators to approximately mid slab depth and provide a locking device to avoid contact with any joint, load transfer device, tie bar, subgrade, or side form. Provide an operating position locking device so that no part of the vibrating unit can be lowered to the extent that it will come in contact with dowel bars, dowel bar assemblies or tie bars while paving.

Set the horizontal spacing of vibrators to the manufacturer's recommendations, but in no case exceed 16" from center to center.

Operate internal and spud vibrators within a frequency range of 3500 to 8000 vpm and surface vibrators within a frequency range of 3500 to 6500 vpm. Operate vibrators in

a manner not to cause a separation of the mix ingredients. A reduction in vibrator frequency may be required when the forward motion of the paver is reduced to avoid separation of the mix. Either discontinue the use or remove from contact with the concrete, the machine mounted vibrators, whenever the forward motion of the machinery is stopped.

Should the electronic monitoring device fail to operate properly, immediately check the vibrators manually in the presence of the Engineer or his representative. If the vibrators are functioning properly, paving may continue. Repair the monitoring device within 3 production days or suspend paving.

700-7 FINISHING

Finish concrete pavement or concrete shoulders in accordance with Article 710-6 or Article 720-7, respectively.

700-8 PROTECTION OF PORTLAND CEMENT CONCRETE PAVEMENT

(A) General

Protect the Portland cement concrete pavement from environmental conditions.

Remove and replace concrete pavement damaged as a result of environmental conditions at no cost to the Department.

Have protective covering that will protect the surface of the freshly placed pavement from rain or cold weather readily available each day at the location of each proposed day's operation prior to beginning work. Store an adequate quantity of these materials at the paving train.

(B) Cold Weather

When the temperature is anticipated to drop below 35°F for more than 6 hours within any 24 consecutive hours of the curing period, defined in Article 700-9, insulate the portland cement concrete pavement to prohibit the concrete from cooling at a rate greater than 5°F per hour, and to prevent the surface temperature from dropping below 40°F during the curing period.

(C) Hot Weather

When the anticipated daily high temperature is above 80°F, place the concrete at the coolest temperature practical. Control concrete temperatures to assure proper placing, consolidation, finishing, curing, and to prevent plastic shrinkage cracking.

(D) Rain

When rain appears imminent, stop all paving operations, and have all available personnel protect the surface of the unhardened concrete. Failure to properly protect the concrete pavement may constitute cause for removal and replacement of the damaged pavement, at no cost to the Department.

700-9 CURING

(A) General

Immediately after finishing operations have been completed and surface water has disappeared, cover all exposed surfaces of the pavement by one of the methods covered by this article.

Apply the selected curing method to the edges of the pavement immediately after the forms are removed.

Use a curing period of 3 curing days for straight cement mix designs and 7 curing days for pozzolan mix designs. A curing day will be considered any consecutive 24 hour period, beginning when the manipulation of each separate mass has been completed, during which the air temperature adjacent to the mass does not fall below 40°F.

(B) Membrane Curing Compound

After final finish and immediately after the free surface moisture has disappeared, use a minimum application rate of 0.0067 gallons per square foot when the application equipment is mechanically operated. Provide an inline flow-metering device to ensure the proper application rate is provided. Apply the curing compound such that puddling or ponding does not occur on the fresh concrete surface.

Use mechanically operated application equipment designed to apply a uniformly agitated continuous flow of the curing compound at the prescribed rate to all concrete surfaces.

Hand spraying shall only be permitted for irregular widths or shapes and surfaces exposed by removal of forms. The rate of application for these areas shall be 0.01 gallons per square foot.

Do not expose newly placed concrete for more than 30 minutes before being covered with curing compound. Failure to cover the surfaces of the concrete shall be cause for immediate suspension of the paving operation.

Protect the membrane curing compound film at all times during the curing period, and repair any damage immediately. Have available a sufficient amount of polyethylene film, burlap, or other approved material to provide for protection of the concrete during rain or when the application equipment fails to apply the curing compound uniformly to all surfaces.

Re-spray concrete surfaces that are subject to heavy rainfall within 3 hours after curing compound has been applied in the same manner as described above.

(C) Polyethylene Film

Spread the sections of the film in a manner that will not damage the finished pavement surface. Securely tape or provide lap joints for the sections that are at least 12" wide, and take suitable precautions to prevent the circulation of air beneath the film. Cover all exposed surfaces and beyond the edge of the pavement surface.

Use black or dark plastic sheets when the daily high ambient temperature is between 40°F - 60°F. Use white opaque reflective plastic sheet when the daily ambient temperature is above 60°F. Plastic sheets will meet the requirements of ASTM C 171.

Check the film for damage when it is spread and during the curing period. Repair or replace any damaged sections immediately.

(D) Burlap

Spread the sections of burlap in a manner that will not damage the finished pavement surface. Provide lap joints that are at least 6" wide.

Use an amount of burlap that is not less than 12 ounces per running yard based on a 40" width and may be either 1 layer of Class 4 burlap or 2 layers of Class 1, 2, or 3 burlap.

Saturate the burlap thoroughly prior to placing on the concrete and keep thoroughly wet throughout the curing period.

700-10 REMOVING FORMS

Do not remove forms from freshly placed concrete until at least 12 hours after placement and the concrete has hardened sufficiently to resist spalling, cracking, or any other damage. Repair any honeycombed areas along the sides or edges of the slab by filling with mortar immediately after the forms have been removed. Use mortar consisting of 1 part cement to 2 parts fine aggregate.

700-11 JOINT CONSTRUCTION

(A) General

Construct all joints in accordance with the requirements of these Specifications and the details shown on the plans. Saw all transverse joints and seal them with joint sealer in accordance with the dimensions and details shown in the contract. Seal joints in accordance with the requirements of Article 700-12.

Utilize an early entry dry-cutting sawing system. Have an adequate amount of sawing equipment available to match the production and concrete paving operations. A minimum of one standby sawing unit is recommended. Construct the joint groove using a 1/8" saw blade to a minimum depth of 3". Perform sawing as soon as the concrete has hardened sufficiently without undercutting, spalling and raveling to control random cracking. Complete all saw cutting before seven hours has elapsed from the time of concrete placement.

Saw the concrete pavement as soon as it can support the weight of the equipment and operator without disturbing the final finish. Saw joints in a neat, vertical straight line without chipping, spalling, tearing or disturbing the final finish.

Immediately reapply curing membrane following the sawing operation.

Deviations from the method of joint construction specified in the plans or Specifications requires prior approval in writing. Such approval is conditional and is subject to obtaining satisfactory results.

The Engineer may order any concrete pavement or shoulder where uncontrolled cracking has occurred prior to final acceptance to be removed and replaced at no cost to the Department. Where permitted, the Contractor may be allowed to repair the cracking in a manner acceptable to the Engineer.

Prior to placing either concrete pavement or concrete shoulders adjacent to a previously placed pavement, cover the transverse joint opening on the edge of the existing slab to prevent intrusion of grout into the opening.

(B) Transverse Contraction Joints

Construct transverse contraction joints in accordance with the details, dimensions and intervals as shown on the plans.

(C) Longitudinal Contraction Joints

Construct longitudinal contraction joints in all pavements wider than 16 feet in accordance with the details and dimensions shown on the plans.

(D) Transverse Construction Joints

(1) **General**

Construct transverse construction joints by use of an approved form at the end of each day's operations (planned joint) or whenever the placing of concrete is suspended for more than 30 minutes (emergency joint).

(2) **Planned Transverse Construction Joints**

Locate this type of joint at the same spacing required for contraction joints. Use dowel bars of the size and spacing shown on the plans.

(3) **Emergency Transverse Construction Joints**

Use this type of joint when the placing of concrete is suspended for more than 30 minutes. Use tie bars of the size and spacing shown on the plans.

Do not change the spacing of contraction joints due to emergency construction joints. Locate the emergency construction joints at least 6 feet from any contraction joint or planned construction joint.

(E) Longitudinal Construction Joints

Construct longitudinal construction joints using tie bars in accordance with the details shown on the plans.

(F) Transverse Expansion Joints

Construct transverse expansion joints in accordance with the details shown on the plans utilizing an approved joint assembly.

700-12 SEALING JOINTS

(A) General

Seal all joints with low modulus silicone sealant in the presence of the Engineer.

Install backer rod and sealant in accordance with the details shown in the plans and the manufacturer's recommendations.

Any failure of the joint material will be cause for rejection. Repair the failed joint material as approved by the Engineer at no cost to the Department.

When requested, have a representative of the silicone sealant manufacturer present on the project during the sealing operation.

(B) Age of Pavement

Do not seal the joints until the concrete is at least 14 calendar days old.

Do not perform final sawing and sealing of concrete pavement joints until after surface testing, correction of surface deficiencies, and all adjacent earth and paved shoulder construction has been completed.

(C) Temperature

Do not place joint sealant when the air temperature near the joint is less than 45°F or is 45°F and falling.

(D) Sealing the Joint

Immediately after sawing the joint to the dimensions as shown on the plans, completely remove the resulting slurry from the joint by flushing with a jet of water under pressure. Use sand blasting to clean joint faces before applying sealant. Make as many passes with a sand blaster as are necessary to provide a clean joint wall.

Blow all joints clear of deleterious materials with air using a nozzle pressure of at least 90 psi before installing the backer rod. Use rotary screw compressors for this purpose that are equipped with traps capable of removing water and oil from the air. Maintain the traps in accordance with manufacturer's instructions.

Apply sealer only on thoroughly clean and dry joints. Place the sealer to closely conform to dimensions shown on the plans. Any unreasonable deviation will be cause for rejection.

(E) Cleaning Pavement

After a joint has been sealed, remove surplus joint sealer on the pavement as soon as possible.

700-13 USE OF NEW PAVEMENT OR SHOULDER

Traffic or other heavy equipment will not be allowed on the concrete pavement or shoulder until the estimated flexural strength of the concrete using the maturity method has exceeded 600 psi unless otherwise permitted.

Estimate the flexural strength of concrete pavement in accordance with the most current version of ASTM C 1074 *Standard Practice for Estimating Concrete Strength by the Maturity Method* unless otherwise specified herein.

Furnish thermocouples or thermistors and digital data logging maturity meters that automatically compute and display the maturity index in terms of a temperature-time factor.

The maturity meters must be capable of storing a minimum of 28 days worth of data and exporting data into an excel spreadsheet. Submit the proposed equipment to the Engineer for approval.

When establishing a strength-maturity relationship, perform flexural tests at ages 1, 3, 5, 7, 14 and 28 days in accordance with Test Method C 78. Substitute flexural strength in lieu of compressive strength when developing the strength–maturity relationship in accordance with ASTM C 1074.

Use the temperature-time factor maturity function to compute the maturity index from the measured temperature history of the concrete. Set the datum temperature at –10°C to calculate the temperature-time factor in Equation 1 of ASTM C 1074.

Establish and submit a strength-maturity relationship in conjunction with each concrete pavement mix design. Determine the temperature-time factor corresponding to the strength-maturity relationship at 600 psi, TTF. Any changes to plant operations, material sources, or mix proportions will affect the strength-maturity relationship. If any changes occur during production, develop a new strength-maturity relationship unless otherwise directed.

Verify the strength-maturity relationship during the first day's production. Utilize the temperature-time factor developed at mix design TTF to verify the production strength-maturity relationship. Verify the strength-maturity relationship at a minimum of every 10 calendar days or when production is suspended for more than 10 days. If the verification sample's strength when tested at TTF is less than 550 psi, immediately suspend early opening of traffic on pavement that has not obtained TTF until a new strength-maturity relationship is developed.

No permanent traffic will be allowed on the pavement until construction of the joints, including all sawing, sealing, and curing that is required, has been completed.

Take particular care to protect the exposed pavement edges and ends.

700-14 CONTRACTOR'S RESPONSIBILITY FOR PROCESS CONTROL

Perform process control sampling and testing of concrete materials and operations in accordance with the requirements of Article 1000-3. The Contractor's roadway foreman and all personnel involved in the batching, sampling, testing, and acceptance of Portland cement concrete pavement shall be NCDOT certified Portland Cement Concrete Pavement Technicians.

700-15 ACCEPTANCE TESTS FOR CONCRETE

(A) Responsibility

The Engineer will conduct acceptance sampling and testing of concrete. Provide access to all materials to be sampled and tested. The following tests will be performed on both concrete pavement and concrete shoulders to determine acceptance.

(B) Lot Definition

A lot for acceptance purposes is defined and described in Article 710-4.

(C) Air Content

The air content of the concrete will be determined on the roadway at a frequency established by the Engineer, and in accordance with Subarticle 1000-3(B). The sample taken for determination of air content will be obtained immediately after the concrete has been discharged on the road.

Concrete failing to meet specification requirements for air content will be subject to rejection.

(D) Slump

The slump of the concrete will be determined in accordance with AASHTO T 119 at a frequency established by the Engineer. The sample taken for determination of slump will be obtained immediately after the concrete has been discharged on the road.

When the slump of the concrete is questionable by visual observation, do not place the concrete on the road until tested for slump by the Engineer.

Concrete failing to meet specification requirements for slump will be subject to rejection.

(E) Flexural Strength

Determine the flexural strength of concrete by testing a minimum of one set of two 6" x 6" x 20" beams at 28 calendar days. Test beams will be made by the Engineer from the concrete as it comes from the mixer. The beams will be made and cured in accordance with AASHTO T 23 except that immersion in saturated lime water will not be required. Beams will be tested by the Engineer in accordance with AASHTO T 97. Furnish curing facilities for the test beams in accordance with Section 725.

(F) Thickness

The thickness of the pavement will be determined by measurement of cores in accordance with AASHTO T 148 as modified by the Department. Copies of the modified test procedures are available upon request from the Construction Unit.

Take 4-inch diameter cores in the presence of the Engineer. Take the cores when the concrete has attained a flexural strength of at least 450 psi and at least 72 hours have elapsed since placement of the pavement. If the concrete has not attained a flexural strength of at least 600 psi, the gross vehicle weight rating of vehicles supporting the coring operation may not exceed 7,000 pounds. Take cores no later than 30 days after the pavement has been placed. The core locations for each lot will be selected at random by the Engineer.

Patch all core holes within 72 hours of taking the core, using a Department approved nonshrink grout compatible with the pavement or shoulder concrete.

(G) Surface Smoothness

Perform acceptance testing for surface smoothness on concrete pavements in accordance with Article 710-7.

SECTION 710
CONCRETE PAVEMENT

710-1 DESCRIPTION

Perform the work covered by this section, including but not limited to designing the concrete mix; furnishing and placing concrete; furnishing of all admixtures and additives; constructing all joints and furnishing joint materials; marking the pavement; curing the pavement and furnishing all curing materials; furnishing concrete necessary for making test beams; performing maturity testing; coring and patching the pavement; calibrating and checking the operation of batching equipment; taking actions necessary to prevent or to repair cracking; sawing and sealing joints; removing and replacing of defective pavement; and constructing Portland cement concrete pavement in accordance with these Specifications and with the lines, grades and dimensions shown on the plans.

710-2 MATERIALS

Refer to Division 10

Item	Section
Portland Cement Concrete	1000
Curing Agents	1026
Joint Filler	1028-1
Low Modulus Silicone Sealant	1028-4
Water	1024-4
Dowels and Tie Bars	1070-6

710-3 COMPOSITION OF CONCRETE

Design the concrete mix in accordance with Section 1000.

710-4 ACCEPTANCE OF CONCRETE

Test the concrete pavement for acceptance with respect to flexural strength and thickness on a lot by lot basis in accordance with the requirements of Article 700-15 and the following requirements:

For all concrete pavement, including mainline, shoulders, ramps, tapers, intersections, entrances, crossovers, and irregular areas not otherwise defined, produce a lot consisting of 1,333.3 square yards or fraction thereof placed within 28 calendar days. From each lot, make a minimum of one set of two 6” x 6”x 20” beams from a randomly selected batch of concrete. The average flexural strength of the two beams is considered one test. If Division of Highways personnel make and test additional sets of beams for a lot, these sets will be averaged with the original set to determine the flexural strength. In the case of low strength, the Engineer reserves the right to use beams made by certified Contractor personnel from the same sample of concrete and tested by Division of Highways personnel to evaluate the

lot. If the Engineer elects to use these beams, the flexural strength of all additional beams tested will be averaged with the original two beam strengths to determine the flexural strength.

710-5 CONSTRUCTION METHODS

Construct concrete pavement in accordance with Section 700.

Place concrete in 2 lane minimum widths in a single operation except as follows:

1. Where the total number of lanes is an odd number, in which case one of the lanes may be placed in a separate operation.
2. Areas such as ramps or auxiliary lanes where the total width is less than 2 lanes.

710-6 FINISHING

Screed and float finish the concrete to the required cross section that minimizes or eliminates hand finishing. Additional water for finishing will not be allowed. Hand finishing will not be permitted except under the following conditions:

(A) Narrow widths, or irregular areas, where operation of mechanical equipment is impractical.

(B) In the event of breakdown of mechanical equipment, hand methods may be used to finish only that concrete deposited on the base when the breakdown occurred.

(C) Abnormal circumstances of short duration subject to approval.

Produce a final finish on the pavement surface true to grade and uniform in appearance and free of irregular, rough, or porous areas.

Following the finishing of the pavement by screeding, floating, and checking with straightedges, further finish the surface of the pavement by burlap dragging, or other acceptable method to produce a uniform surface texture. Pull the burlap drag in a longitudinal direction.

Produce the final surface finish on all mainline pavement, auxiliary lanes, and ramps by mechanical equipment for grooving plastic concrete which utilizes spring steel tines. Hand finishing may be permitted when the use of mechanical equipment is impractical. Use mechanical equipment that produces transverse grooves that are spaced at random intervals of 1/2", 5/8", or 3/4" center to center. Do not overlap adjacent grooving. Produce grooves in the hardened surface, which are 0.08 inches to 0.12 inches wide and 0.15 inches to 0.25 inches deep.

After final finishing, hand finishing may be required on the edges of pavement and/or joints whenever irregularities in surface texture or alignment occur. Care should be taken in hand finishing pavement edges in order to avoid ridges or high places that will prevent water from draining out of the transverse grooves.

The use of excessive water during the finishing operations will not be permitted.

710-7 FINAL SURFACE TESTING

Perform acceptance testing of the longitudinal profile of the finished pavement surface in the presence of the Engineer. Furnish and operate a Rainhart Profilograph (Model No. 860) to determine and record the longitudinal profile on a continuous graph (profilogram) for acceptance testing of the pavement. Take profiles the day after the pavement has been placed except where impractical, but in no event later than 72 hours following placement of the pavement.

Operate the profilograph over the pavement at a speed not exceeding 2 miles per hour. If a propulsion vehicle is used, it shall be approved, and the gross vehicle weight shall not exceed 1,000 pounds. Take profiles with the recording wheel parallel to and approximately 3.5 feet inside the two outer edges of the travel lanes and at the location of each longitudinal joint. Take profiles over the entire length of through lane and ramp pavement exclusive of structures and approach slabs. Take additional profiles only to define the limits of an out-of-tolerance surface variation. Upon completion of each day's testing, submit the profilograms to the Engineer for analysis. The Engineer will retain the profilograms.

At the beginning and end of each day's testing, and at other times as determined necessary, operate the profilograph over a calibration strip so that the Engineer can verify correct operation. The Engineer will select the section of pavement used as the calibration strip. Furnish obstructions of known dimensions and temporarily install them in the path of the profilograph. Operate the profilograph in the same manner as it is operated over pavement outside of the calibration strip.

Plot the profilogram at a horizontal scale of 25 feet per inch with the vertical scale plotted at a true scale. Record station numbers and reference lines on the profilograms, and make sure that the distances between reference locations do not exceed 200 feet.

The Engineer will determine the profile index in accordance with the procedure titled "Determination of Profile Index". Copies of this procedure can be obtained from the Construction Unit.

Construct the concrete so that the completed concrete pavement surface has a profile index (PI) along any line tested not exceeding 25 inch per mile, as determined with a 0.00 inch blanking band, over any 600 foot section of pavement. Individual deviations shall not exceed 0.3" over any 25 foot length of the line tested. Correct areas found to exceed this tolerance by grinding and texturing or by using other approved corrective measures that produce smooth and skid resistant surfaces. Verify corrective measures have obtained the smoothness requirements.

Promptly repair membrane curing compound damaged during acceptance testing.

In the event the Contractor does not produce a pavement surface that meets the requirements of this section, the Engineer may suspend the Contractor's operations until such time as the Contractor satisfies the Engineer, by making necessary adjustments to equipment, methods, or personnel, that he can produce a pavement surface that will meet these surface requirements.

The use of excessive grinding to meet these requirements will not be permitted.

710-8 PAVEMENT MARKING

Mark the pavement at locations as shown on the plans with station numbers. Mark the pavement by pressing beveled-face metal dies between 4" and 6" high into the plastic concrete.

At locations where shoulder drain outlets are placed, mark the edge of pavement nearest the outlet to indicate the presence of the outlet. Provide a mark consisting of the letters "OL". Use the same marking procedure as for station numbers.

710-9 THICKNESS TOLERANCES

A lot for thickness acceptance testing is defined in Article 710-4.

To establish an adjusted unit price, if appropriate, for mainline pavement, take one four-inch diameter core from each lot at a random location as directed. Core each location in the presence of the Engineer and deliver the core to the Engineer for measurement.

Other areas such as intersections, entrances, crossovers, ramps, etc. will each be considered as one lot and the thickness of each of these lots will be determined separately. Small irregular areas may be included as part of another lot. Take one core for each 1,333.3 square yards of pavement or fraction thereof in the lot

When the measurement of the core from a lot is not deficient more than 0.2" from the plan thickness, full payment will be made. When such measurement is deficient by more than 0.2" and not more than 1.0" from the plan thickness, take 2 additional cores at intervals not less than 300 feet apart within the lot and determine the average of the 3 cores. In determining the average thickness of the pavement, the Engineer will use all 3 core measurements with the exception that measurements which are in excess of the plan thickness by more than 0.2" will be considered as the plan thickness plus 0.2". If the average measurement of these 3 cores is not deficient more than 0.2" from the plan thickness, full payment will be made. If the average measurement of the 3 cores is deficient more than 0.2" but not more than 1.0" from the plan thickness, an adjusted unit price provided in Subarticle 710-11(B) will be paid for the lot represented.

When the measurement of any core is less than the plan thickness by more than 1.0", the actual thickness of the pavement in this area will be determined by taking additional cores at not less than 10 foot intervals parallel to the center line in each direction from the affected location until in each direction a core is found which is not deficient by more than 1.0". Areas found deficient in thickness by more than 1.0" will be removed and replaced with concrete of the thickness shown on the plans. Exploratory cores for deficient thickness will not be used in averages for adjusted unit price. Patch all core holes within 72 hours of taking the core, using a Department approved nonshrink grout compatible with the pavement concrete.

710-10 MEASUREMENT AND PAYMENT

(A) General

The quantity of portland cement concrete pavement to be paid for will be the actual number of square yards of concrete pavement that has been completed and accepted. In measuring this quantity, the width of the pavement will be as called for on the

plans or as directed. The length will be the actual length constructed, measured along the centerline of the pavement.

Separate measurement will be made of pavement that is deficient in thickness by more than 0.2" and of pavement that is deficient in flexural strength.

The quantities of portland cement concrete pavement will be paid for at the contract unit price per square yard for "____ Inch Portland Cement Concrete Pavement, Through Lanes, (with dowels)", "____ " Portland Cement Concrete Pavement, Ramps, (with dowels)", or ____ " Portland Cement Concrete Pavement, Miscellaneous, (without dowels)", or if applicable, at such contract unit prices adjusted in accordance with the requirements shown below. No unit price adjustments on lots will be made until a final determination of the lot strength and depth is made. Pavement will be classified as through lane, ramp, or miscellaneous pavement in accordance with the classification shown on the plans.

Payment for all work of surface testing will be made at the contract lump sum price for *Surface Testing Concrete Pavement*. Partial payments for surface testing will be proportional to the percentage of pavement which has been surface tested at the time the partial estimate is prepared.

(B) Pavement Deficient In Thickness

The quantities of portland cement concrete pavement which are deficient in thickness by more than 0.2" but not deficient by more than 1.0", measured as provided in Article 710-10, will be paid for at an adjusted contract unit price per square yard for "____ Inch Portland Cement Concrete Pavement, Through Lanes, (with dowels)", or "____ Inch Portland Cement Concrete Pavement, Ramps, (with dowels)", or "____ Inch Portland Cement Concrete Pavement, Miscellaneous, (without dowels)" completed in place and accepted. The adjusted contract unit price will be as follows:

Deficiency, Inches	Pay Factor (%)
0.00 to 0.20	100
0.21 to 0.30	80
0.31 to 0.40	72
0.41 to 0.50	68
0.51 to 0.75	57
0.76 to 1.00	50

Pavement areas deficient in thickness by more than 1.0" will be removed and replaced.

Where pavement deficient by more than 1.0" is removed and replaced, the replacement pavement will be paid for at the contract unit price per square yard for "____ Inch Portland Cement Concrete Pavement, Through Lanes, (with dowels)", or "____ Inch Portland Cement Concrete Pavement, Ramps, (with dowels)", or "_____ Inch Portland Cement Concrete Pavement, Miscellaneous, (without dowels)" which price and payment will be full compensation for all work of placement, removal, restoration of subgrade and base, and replacement.

(C) Concrete Pavement Varying In Flexural Strength

The pay factor for pavement achieving a flexural strength in 28 days of 650 psi or greater is 100%. The pay factor for pavement achieving a flexural strength in 28 days between 600 psi and 650 psi is determined by the following formula:

$$\left[\text{Pay Factor (\%)} = 100.0 - \frac{650 - \text{PSI}}{\text{(pay factor rounded to nearest tenth of one percent)}}\right]$$

The quantities of portland cement concrete pavement that meet these criteria, will be paid for at an adjusted unit price per square yard for "____ Inch Portland Cement Concrete Pavement, Through Lanes, (with dowels)", or "____ Inch Portland Cement Concrete Pavement, Ramps, (with dowels)", or "____ Inch Portland Cement Concrete Pavement, Miscellaneous, (without dowels)" completed in place and accepted. The adjusted contract unit price will be determined by multiplying the contract unit price by the pay factor level determined for the average strength of concrete in each lot and will be applicable to the total square yards of concrete in each lot.

Any pavement that fails to attain 600 psi is subject to removal. If allowed to remain in place, the pavement will be accepted at a reduced unit price based on a pay factor level of 50% as provided in Article 105-3.

Where pavement deficient in strength is removed and replaced, the replacement pavement, if acceptable, will be paid for at the contract unit price for "____ Inch Portland Cement Concrete Pavement, Through Lanes, (with dowels)", or "____ Inch Portland Cement Concrete Pavement, Ramps, (with dowels)", or "____ Inch Portland Cement Concrete Pavement, Miscellaneous, (without dowels)" which price and payment will be full compensation for all work including placement, removal, restoration of subgrade and base, and replacement.

(D) Multiple Adjustments in Price

Pavement found deficient in both thickness and strength will be evaluated by the Engineer to determine if it may be permitted to remain in place. Pavement permitted to remain in place will be paid for at a reduced price determined by successively multiplying the contract price by the appropriate factor indicated for each deficiency.

(E) Compensation

Payment at the contract unit prices for "____ Inch Portland Cement Concrete Pavement, Through Lanes, (with dowels)" and "____ Inch Portland Cement Concrete Pavement Ramps, (with dowels)" and "____ Inch Portland Cement Concrete Pavement, Miscellaneous, (without dowels)" will be full compensation for all work covered by this section.

Payment at the contract lump sum price for "Surface Testing Concrete Pavement" will be full compensation for all work of surface testing including but not limited to

furnishing, maintaining, and operating the profilograph and towing equipment; for furnishing graph paper and any other materials and supplies for performing the surface testing; and for repairing membrane curing compound damaged during surface testing.

(F) Payment will be made under

Pay Item	Pay Unit
__" Portland Cement Concrete Pavement, Through Lanes (with dowels)	Square Yard
__" Portland Cement Concrete Pavement, Ramps (with dowels)	Square Yard
__" Portland Cement Concrete Pavement, Miscellaneous (without dowels)	Square Yard
Surface Testing Concrete Pavement	Lump Sum

SECTION 720
CONCRETE SHOULDERS

720-1 DESCRIPTION

Perform the work covered by this section including but not limited to the construction of portland cement concrete shoulders in accordance with these Specifications and with the lines, grades, and dimensions shown on the plans; designing the mix; furnishing and placing the concrete shoulders; furnishing maturity testing equipment; furnishing all admixtures and additives; constructing joints; furnishing joint materials; curing the shoulder and furnishing curing materials; coring and patching core holes; taking actions to prevent or repair cracking; and removing and replacing unsatisfactory shoulder.

720-2 MATERIALS

Refer to Division 10

Item	Section
Portland Cement Concrete	1000
Curing Agents	1026
Joint Filler	1028-1
Low Modulus Silicone Sealant	1028-4
Water	1024-4
Dowels and Tie Bars	1070-6

720-3 COMPOSITION OF CONCRETE

Design the concrete mix in accordance with Section 1000.

720-4 ACCEPTANCE OF CONCRETE

Concrete shoulders will be tested for acceptance with respect to flexural strength and thickness on a lot by lot basis. A lot is defined in Article 710-4.

720-5 EQUIPMENT

Use equipment in the production and placement of the concrete shoulders in accordance with Section 700 and Section 1000.

720-6 CONSTRUCTION METHODS

Place the concrete shoulders only in the presence of an authorized representative of the Engineer. Construct concrete shoulders in accordance with Section 700.

Place the full width of the shoulder in a single operation.

720-7 FINISHING

Finish the shoulder surface with approved equipment. Hand finishing will be permitted when the use of mechanical finishing equipment is impractical.

Perform the final finishing of the shoulder surface by burlap dragging or brooming, or other acceptable methods that will produce a similar surface texture acceptable to the Engineer.

720-8 JOINTS

Construct and seal all joints in accordance with Article 700-11 and 700-12 except as provided in this article. Saw all joints in the concrete shoulder and seal with joint sealer as shown in the plans.

Dowels will not be required at the transverse joints in the concrete shoulder. Use tie bars between the concrete pavement and the concrete shoulder.

Match the transverse joints in the concrete shoulder with the transverse joints in the adjacent concrete pavement.

720-9 THICKNESS TOLERANCES

The thickness of the shoulder will be determined by measurement of cores tested in accordance with AASHTO T 148 as modified by the Department. Copies of the modified test procedures are available upon request from the Construction Unit.

A lot for thickness acceptance testing is defined in Article 710-4.

Take one core from each lot at a random location as directed. Core each location in the presence of the Engineer. Take cores with a diameter of 4" and deliver them to the Engineer for measurement. When the required thickness for the shoulder varies, each core will be measured and compared to the required thickness for the shoulder at the location of the core. The deviation of the measured core thickness from the required thickness will be recorded as a plus or minus value for each core. Thickness tolerances in Article 710-9 apply for concrete shoulders.

720-10 MEASUREMENT AND PAYMENT

(A) General

Concrete Shoulders Adjacent to __" Pavement will be measured and paid for as the actual number of square yards of shoulders that have been completed and accepted. In measuring this quantity, the width of the shoulders will be as called for on the plans or as directed by the Engineer. The length will be the actual length constructed, measured along the surface of the shoulders at the centerline of each shoulder.

(B) Shoulder Deficient in Thickness

Pay factors are determined in accordance with Subarticle 710-11(B). When the shoulder is deficient in thickness by more than 1", the Engineer will determine if the shoulder can be left in place or be removed and replaced. Where the Engineer determines the shoulder can be left in place, the shoulder will be accepted at a reduced unit price not to exceed 50% as provided in Article 105-3.

(C) Concrete Shoulder Varying In Flexural Strength

Concrete shoulders shall meet the strength requirements of Subarticle 710-11(C).

The quantities of concrete shoulder that fail to meet 650 psi, measured as provided in Article 710-10, will be paid for at an adjusted unit price per square yard, completed in place and accepted. The adjusted contract unit price will be determined by multiplying the contract unit price by the pay factor level determined for the average strength of concrete in each lot and will be applicable to the total square yards of concrete in each lot.

Where concrete shoulder deficient in strength is removed and replaced, the replacement pavement, if acceptable, will be paid for at the contract unit price for Concrete Shoulders Adjacent to ____ Inch Pavement, which price and payment will be full compensation for all work of placement, removal, and replacement.

(D) Multiple Adjustments in Price

Concrete shoulder found deficient in both thickness and strength will be evaluated by the Engineer to determine if it may be permitted to remain in place. Concrete shoulder permitted to remain in place will be paid for at a reduced price determined by successively multiplying the contract price by the appropriate factor indicated for each deficiency.

(E) Pay Items

Payment will be made under:

Pay Item	Pay Unit
Concrete Shoulders Adjacent to __" Pavement	Square Yard

SECTION 725
FIELD LABORATORY FOR PORTLAND CEMENT CONCRETE PAVEMENT

725-1 DESCRIPTION

Perform the work covered by this section including but not limited to providing and maintaining the building or trailer and the curing shelter for the exclusive use of the Engineer at concrete plants producing portland cement concrete for use in pavement to be constructed on the project; furnishing water, heat, electricity, and other utility services; and any other equipment that may be necessary.

725-2 GENERAL REQUIREMENTS

Furnish and maintain for the exclusive use of the Engineer a field laboratory in which to house and use all testing equipment needed. Provide a laboratory that is dust and water tight, floored, and has an adequate foundation so as to prevent excessive floor movement. Provide a laboratory which contains 6 or more 110 volt electrical double outlets properly grounded and spaced; a telephone; at least 2 windows, satisfactory locks on all doors and windows; adequate lighting, heating, and air conditioning; sink; running water to sink; and satisfactory exhaust fan. Provide a laboratory that meets the following approximate minimum requirements: 200 square feet of floor space; 10 feet interior width; 6 feet 6 inches interior height; 20 square feet of counter space, 2.5 to 3 feet high and 2 feet deep with cabinets or drawers below the counter top; and 6 square feet of desk space not enclosed with cabinets. Locate the laboratory in a position that will permit full view of the plant from the interior of the laboratory. At or near the laboratory, furnish toilet facilities, with waste disposal, available for use of the Department personnel. Maintain these toilets in a neat and clean condition.

Provide a curing shelter adjacent to the laboratory that is at least 200 square feet in area, approximately 10 feet wide, 20 feet long, and 7 feet in height. Provide a workbench that is approximately 10 feet long, 2 feet wide, and 2 feet high across the end of the shelter. Provide, in the shelter, a sand bed at least 1 foot deep, and approximately 10 feet wide and 14 feet long, which is enclosed on all 4 sides by timbers. Equip the shelter with curtains made of burlap, canvas, or other suitable materials, that may be raised or lowered to protect the sand bed and workbench from the sun. Furnish a wooden mixing board at least 3/4" thick and approximately 4 feet wide and 4 feet long, which is covered on one side with sheet metal of at least 22 gage, at the shelter. Provide a water supply to maintain the sand bed in a moist condition. Provide facilities to maintain the test beams at temperature between 60°F and 80°F during curing.

In lieu of equipping the curing shelter with a sand bed as required above, the Contractor may provide a similar facility meeting all of the above requirements except equipped with water storage tanks. Construct the water storage tanks of non-corroding materials and have requirements for automatic control of the water temperature. Maintain the water in the tank at a temperature of 73°F ±3°F. Equip each tank with a recording thermometer with its bulb located in the water. Provide sufficient tank volume to maintain all beams, stored with the

long axis vertical, in a fully submerged condition for the duration of the required curing period.

725-3 MEASUREMENT AND PAYMENT

Field Laboratory Rental, Portland Cement Concrete Pavement will be paid for at the contract lump sum price which will be made for furnishing and maintaining all field laboratories which have been made available for use by the Engineer at any concrete plant producing portland cement concrete for use in pavement to be constructed on the project. Partial payments for field laboratory rental will be made with the first and last partial pay estimates which include concrete pavement and/or concrete shoulders. Payments will be made at the rate of 50 percent of the lump sum price for "Field Laboratory Rental, Portland Cement Concrete Pavement" on each of these partial pay estimates.

Payment will be made under

Pay Item	**Pay Unit**
Field Laboratory Rental, Portland Cement Concrete Pavement	Lump Sum

DIVISION 8
INCIDENTALS

SECTION 800
MOBILIZATION

800-1 DESCRIPTION

This work consists of preparatory work and operations to mobilize personnel, materials and equipment to the project site.

800-2 MEASUREMENT AND PAYMENT

Mobilization will be paid for as contract lump sum price.

Partial payments for mobilization will be made with the first and second partial pay estimates paid on the contract, and will be made at the rate of 50% lump sum price on each of these partial pay estimates, provided the amount bid for mobilization does not exceed 5 percent of the total amount bid for the contract. Where the amount bid for the item of mobilization exceeds 5 percent of the total amount bid for the contract 2½ percent of the total amount bid will be paid on each of the first two partial pay estimates, and that portion exceeding 5 percent will be paid on the last partial pay estimate.

As an exception to the above, where the work covered by the contract is limited exclusively to the resurfacing of an existing pavement, payment of the entire lump sum price for Mobilization will be made with the first partial pay estimate paid on the contract, provided the amount bid does not exceed 5 percent of the total amount bid for the contract. Where the amount bid for Mobilization exceeds 5 percent of the total amount bid for the contract, 5 percent of the total amount bid will be paid on the first partial pay estimate. That portion exceeding 5 percent will be paid on the last partial pay estimate.

Such price and payment includes but is not limited to the movement of personnel, equipment, supplies, and incidentals to the project site, for the establishment of offices, buildings, and other facilities necessary for work on the project; the removal and disbandment of those personnel, equipment, supplies, incidentals, or other facilities that were established for the prosecution of work on the project; and for all other work and operations that shall be performed for costs incurred prior to beginning work on the various items on the project site.

Payment will be made under:

Pay Item	Pay Unit
Mobilization	Lump Sum

SECTION 801
CONSTRUCTION STAKES, LINES AND GRADE

801-1 DESCRIPTION

When required by the contract, provide all construction layout, surveying, stakeout, supplemental surveying, and engineering necessary for the proper control of construction operations in accordance with this section and the most current version of the *Manual for Construction Layout*. Provide a stakeout of areas where an environmental permit is required prior to performing any construction in or adjacent to these areas. Stake out limits of the permitted work areas according to the approved permit drawings. Provide clear delineation by use of highly visible flagging. Insure construction limits do not exceed approved permitted work areas. Immediately notify the Engineer of any variations of the stakeout limits when compared to the approved permit drawings.

The *Manual for Construction Layout* and the *Guidelines for Drainage Studies and Hydraulic Design* may be obtained from the Project Services Unit.

801-2 CONSTRUCTION METHODS

(A) General

Furnish personnel who are under the direct supervision of a North Carolina Licensed Professional Engineer and/or Licensed Professional Land Surveyor in conformance with GS 89C.

Furnish personnel who are experienced in highway construction surveying and are capable of accurately establishing all line and grade points necessary to complete the work in accordance with the plan dimensions within the precision established in the most current version of the *Manual for Construction Layout*.

Consult the Engineer for clarifications of the plans.

Perform work in safe manner and conform to the requirements of Article 107-22. Install in accordance with Section 1110, the appropriate advance warning signs as detailed in the most current version of the *Manual for Construction Layout*.

Perform all flagging operations in accordance with the provisions of Section 1150.

The Contractor may elect to utilize Global Positioning System (GPS) surveying, either static or kinematic. Perform GPS surveys with same or higher order of accuracy as conventional surveys detailed in the most current version of the *Manual for Construction Layout.* Department projects utilize a localized coordinate system developed by the Location and Surveys Unit specifically for each individual project. Obtain the control information that the Location and Surveys Unit utilized in establishing the localized coordinate system, specifically the Rotation, Scaling, Translation and coordinates for the azimuth pairs. Newly developed GPS procedures and techniques that do not conform to the Specifications in this section may be used if approved.

Investigate the plan horizontal alignment, vertical profile, and superelevation of existing facilities that tie to proposed roadways. Investigate 100 feet beyond all

paving limits and advise the Engineer if revisions are needed to establish smooth transitions to the existing facilities. When directed, further investigation will be considered Supplemental Field Surveying.

Tie existing driveways to proposed facilities within the limits detailed in the plans and within the gradients detailed in the Standard Drawings.

Surveying and office calculations performed specifically for the relocation of utility conflicts are considered Supplemental.

The Engineer reserves the right to check, correct where necessary, or require any layout work to be revised. The Engineer will perform checks to ensure the roadway, structure and incidental items are surveyed in accordance with the plans and the most current version of the *Manual for Construction Layout*.

The Department's review of the Contractor's work in no way relieves the Contractor of responsibility for conformance with the contract. Failure by the Engineer or inspector to point out unsatisfactory work, from lack of discovery or for any other reason, in no way prevents later rejection or corrections to the unsatisfactory work, when discovered, at no cost to the Department. No claims will be allowed for losses suffered due to any necessary removals or repairs resulting from the unsatisfactory work.

When requested by the Engineer, check the accuracy of the stakeout. When the original stakeout is found to be correct, the surveying required to check the accuracy will be considered Supplemental Field Surveying. When the original stakeout is found to be in error, perform the work required to check and correct the stakeout at no cost to the Department.

Correct all inaccuracies in the construction stakeout prior to performing the affected work.

When the Contractor proposes an alteration to the plans to rectify a construction stakeout error, submit alterations to the Engineer for review and approval. Include design calculations and drawings sealed by an appropriate Licensed Professional Engineer along with a narrative describing justification for the alteration.

When surveying is required, which in the Contractor's opinion could not have been reasonably anticipated and is not customary or inherent to the construction industry, notify the Engineer in writing prior to beginning such surveying. After investigation, the following will occur:

(1) When the Engineer determines that the surveying could not have been anticipated or is not customary or inherent to the construction industry, the Contractor will be notified in writing that the work is considered supplemental and measurement and payment will be made in accordance with Article 801-3.

When the Engineer determines that the surveying could have been anticipated or is customary or inherent to the construction industry, he will notify the Contractor, in writing, of his determination. If the Contractor intends to file a claim for additional compensation by reason of such surveying, notify the

Engineer in writing of such intent prior to beginning any of the alleged supplemental surveying. Strictly adhere to the requirements of Subarticle 104-8(B).

(B) Records

Submit proposed method for setting up survey books or electronic data files to the Engineer before beginning work to assure clarity and adequacy.

In a timely manner, make available to the Engineer all requested survey records.

On a monthly basis, provide to the Engineer updated electronic and/or manuscript survey records. Submit remaining records upon completion of the work. Attest the work was performed in accordance with the contract by providing all receivable information signed by the Licensed Professional Engineer and/or Licensed Professional Land Surveyor in responsible charge.

(C) Horizontal and Vertical Control

The Department will furnish and set horizontal baseline control on approximate 1000 foot intervals and vertical control on approximate 2500 foot intervals within the project limits.

Obtain text of baseline control from Engineer.

Clearing limits may be established during original traverse of baseline control provided the accuracy ratio does not exceed 1 foot per 5000 feet of perimeter and all Department established baseline control is protected and preserved during clearing operations. Prior to performing any additional construction layout, verify the horizontal baseline control by a closed traverse survey or alternate approved method. The accuracy ratio shall not exceed an error of closure of 1 foot per 20,000 feet of perimeter. Verify the vertical control by performing a closed loop survey utilizing differential leveling. For the error of closure, do not exceed 0.05 feet $\sqrt{(x)miles}$. Notify the Engineer of any discrepancies in either the horizontal or vertical control. Reference, outside of the proposed construction limits and evenly distributed throughout the project limits, fifty percent of the Department's horizontal and vertical control. Provide reference information to the Engineer.

If GPS is utilized, occupy the azimuth pairs with the base station during verification of baseline control, otherwise, occupy baseline. Verify remaining baseline control utilizing a Rover. Submit coordinate data showing differences between supplied baseline coordinates and field obtained GPS coordinates. Include report detailing the use of preliminary input data, specifically Rotation, Scaling, and Translation.

Utilizing the horizontal and vertical control established by the Department, provide surveying necessary to construct all roadway, structure, and miscellaneous items as detailed in the plans. Perform staking in accordance with the most current version of the *Manual for Construction Layout*. Layout the work and provide all measurements that may be required for the execution of the construction in conformity with the contract.

(D) Right of Way and Easements

The Department will establish the location of all proposed right of way markers and permanent drainage easements.

Reference the location of all proposed right of way markers and permanent drainage easements. Restore right of way monument positions after completion of construction. Set a right of way monument cap on an 18" long #5 reinforcing bar and a carsonite witness stake unless concrete right of way markers are specified in the contract. The Department will provide the monument cap and witness stake. Re-establish location of permanent drainage easements after completion of construction and install an 18 long #5 reinforcing bar for monumentation.

Validate the position of the right of way and permanent drainage easement locations with those detailed in the plans. Report any discrepancies to the Engineer.

(E) Cross-sections for Earthwork Quantities

The Engineer may elect to obtain cross sections either by hand or aerial methods. If the Engineer elects to obtain cross sections by aerial methods, furnish materials and install photogrammetric control panels in accordance with the most current version of the *Manual for Construction Layout* or as otherwise directed.

(1) Borrow Pits

Establish a baseline alignment within each borrow pit, as necessary, to allow the Engineer to obtain measurement of quantities for payment. Stake these alignments just before field cross sections are taken by the Engineer for original, intermediate, and final cross sections. Establishment of baseline alignments within each borrow pit is considered incidental to Construction Surveying.

(2) Roadway

Unless otherwise directed, stakeout the survey lines for original and final cross sections. The stakeout of the survey lines will consist of surveying and staking all alignments within the plans on 50 foot intervals, including all cardinal points. When the alignments are inaccessible, install offset alignments. Begin the staking of these alignments within 48 hours of the Engineer's notice to proceed. Upon the completion of the entire project, with the exception of the survey line for final cross sections, and upon request by the Contractor, the project may be accepted for maintenance by the Department, excluding the survey line.

If the Engineer determines intermediate cross sections are necessary for computing partial payments, perform the stakeout of the survey line for intermediate cross-sectioning as Supplemental Field Surveying; otherwise the intermediate stakeout of the survey line is incidental to the work.

(F) Drainage and Utility Construction Systems

(1) General

Where underground conflicts are suspected, contact utility owners and locate all utilities horizontally and vertically. Consider the utilities' locations and elevations in the layout of the drainage systems and utility construction systems. Utilities may exist that are not depicted on the plans.

Submit two copies of all layout drawings for drainage systems and utility construction systems to the Engineer for his review and approval. The Engineer will note the review and approval by adding an appropriate note to the drawings along with the date and his signature. The Engineer will retain a copy of the drawings and a copy will be returned to the Contractor.

(2) Drainage Systems

Provide construction layout of drainage systems, as depicted in the plans and in accordance with the *Guidelines for Drainage Studies and Hydraulic Design.* Consider the locations and elevations of all existing and proposed utilities, proposed utility construction, and existing and proposed drainage systems, in the layout of the drainage system. Modifications of the drainage plan may be necessary to properly collect and transport water. Advise the Engineer if modifications are needed to achieve the original design functionality and the intent of the drainage plans, such as adjusting the location of a drainage structure, adding a drainage structure, and increasing or decreasing pipe lengths. The Engineer will review any major modifications.

Provide layout drawing of the drainage system including calculations of flow line elevations for all drainage structures; pipe invert elevations, both inlet and outlet of the drainage structure; grade of each pipe within the drainage system; elevation of any existing facility connection, such as stream or pipe; pipe camber, if necessary; headwall location, if depicted in the plans; and locations and elevations of any existing or proposed utilities to the Engineer for review and approval a minimum of seven days prior to beginning work on the drainage system. Modification of the submitted drainage layout drawing by the Engineer will not eliminate the Contractor's liability for the accuracy of the information submitted. Any restaking or additional staking required to conform with the approved drainage layout drawing is considered incidental to the work.

(3) Utility Construction

Provide utility construction layout as detailed in the contract. Consider the locations and elevations of all existing and proposed utilities, proposed utility construction, and existing and proposed drainage systems, in the layout of the utility construction. Advise the Engineer if modifications to the utility construction plans are necessary. The Engineer will review any major modifications.

Provide layout drawing of the utility construction system including elevations of any existing utilities, drainage systems, and/or proposed drainage systems to the Engineer for review and approval a minimum of seven days prior to beginning work on the utility construction system. Modification of the submitted utility construction layout drawing by the Engineer will not eliminate the Contractor's liability for the accuracy of the information submitted. Any restaking or additional staking required to conform with the approved utility layout drawing is considered incidental to the work.

(G) Structures

Provide surveying and calculations necessary to construct structures in accordance with the plans. Provide staking in accordance with the most current version of the *Manual for Construction Layout*. Establish horizontal alignment of entire structure. Set a minimum of one benchmark adjacent to the structure site that will be retained throughout the structure construction. The Engineer will furnish the finished construction elevations for use in determining the required construction elevations for bridges. Provide method for computing buildups over beams, screed grades, and overhang form elevations to the Engineer for review prior to staking these items to assure clarity and adequacy.

Submit two copies of structure layout drawings to the Engineer for his review and approval. The Engineer will independently verify and accept the structure layout before the structure construction may begin. The Engineer will note the review and approval by adding an appropriate note to the drawings along with the date and his signature. The Engineer will retain a copy of the drawings and a copy will be returned to the Contractor.

If structure phasing or damaged stakes require significant resurveying during the life of the structure, provide revised layout drawing for the Engineer's verification and acceptance.

(H) Signs

Stake horizontal location of all overhead and type A and B ground mounted signs for Engineer's verification prior to obtaining s-dimensions. Measure or calculate overhead and ground mounted sign s-dimensions in accordance with the plans and the most current version of the *Manual for Construction Layout*. Perform investigation of proposed sign locations and notify the Engineer of any obstructions, either existing or proposed, that may interfere with the proposed sign installation. Provide an 11" x 17" drawing depicting the theoretical finished section at each proposed overhead sign assembly location. Include within the submittal the roadway, shoulder, and slope gradients. Also include the proposed finish elevations of the edges of pavement, each lane line, and the ground at each proposed sign footing location. Set a slope stake at each proposed overhead sign location to ensure the slopes are constructed as calculated and detailed in the above submittal. Submit sign information to the Engineer.

801-3 MEASUREMENT AND PAYMENT

Construction Surveying will be paid for at the contract lump sum price for the work detailed in this section.

Partial payments will be made on each particular payment estimate based upon the percentage complete of Construction Surveying as determined by the Engineer. The Contractor shall submit a certified statement each month indicating the percentage of Construction Surveying work completed. The Engineer will determine if the amount indicated is reasonably correct and the Engineer will pay accordingly on the next partial pay estimate.

Supplemental Field Surveying will be measured and paid for as the actual number of hours the Contractor's survey crew is actively engaged in performing the following:

(A) Investigative surveying, in excess of 100 feet of horizontal alignment, vertical profile, and superelevation of existing facilities that tie to proposed roadways.
(B) Surveying specifically for the relocation of utility conflicts.
(C) Investigation of a previous stakeout when such stakeout is found to be correct.
(D) Surveying that the Engineer has deemed could not have been anticipated or is not customary or inherent to the construction industry.
(E) The stakeout of the roadway survey alignments for intermediate cross sections when deemed necessary by the Engineer.

Supplemental Surveying Office Calculations will be measured and paid for as the actual number of hours the Contractor's survey personnel is actively engaged in performing office calculations specifically associated with the following:

(A) Investigative surveying, in excess of 100 feet of horizontal alignment, vertical profile, and superelevation of existing facilities that tie to proposed roadways.
(B) Surveying specifically for the relocation of utility conflicts.
(C) Investigation of a previous stakeout when such stakeout is found to be correct.
(D) Surveying that the Engineer has deemed could not have been anticipated or is not customary or inherent to the construction industry.
(E) The stakeout of the roadway survey alignments for intermediate cross sections when deemed necessary by the Engineer.

Supplemental Surveying Office Calculations will be paid at the stated price of $50.00 per hour. *Supplemental Field Surveying* will be paid at the stated price of $100.00 per hour. The payment includes furnishing personnel, all surveying equipment, stakes, layout drawings, calculations, stakeout records, and any materials and equipment necessary to perform the surveying and engineering work.

The payment includes furnishing personnel, all surveying equipment, stakes, layout drawings, calculations, stakeout records, and any materials and equipment necessary to perform the surveying and engineering work.

Exploratory Excavation required to locate a utility will be paid for in accordance with Article 104-7.

Work Zone Signs (Portable) will be paid for in accordance with Article 1110-4.

Flaggers will be paid for by either the hour or day in accordance with Article 1150-4.

Any payments for Supplemental Field Surveying or Supplemental Surveying Office Calculations required by this Specification will be paid on the appropriate partial payment estimate.

Payment will be made under:

Pay Item	Pay Unit
Construction Surveying	Lump Sum
Supplemental Field Surveying	Hour
Supplemental Surveying Office Calculations	Hour

SECTION 802
DISPOSAL OF WASTE AND DEBRIS

802-1 DESCRIPTION

The work consists of the disposal of waste and debris in accordance with the requirements of these Specifications including, but not limited to, furnishing any waste areas; providing and implementing a Development, Use, and Reclamation Plan; any right of access to waste areas; disposing of waste and debris; dressing and shaping of waste areas; furnishing and spreading earth material over debris, rock, broken pavement, and masonry; clearing and grubbing of waste areas; and hauling waste and debris to waste areas or permitted landfills; assessment for wetlands and endangered species; obtaining required permits and/or certifications; and any tipping fees required for disposal in permitted landfills.

Waste will be considered to be all excavated materials that are not utilized in the construction of the project, including overburden from borrow sources and soil type base course sources.

Debris is all undesirable material encountered on the project.

802-2 GENERAL REQUIREMENTS

Provide an area and dispose of waste and debris outside of the right of way, unless otherwise allowed by written request. Limit the materials placed in non-permitted disposal areas to clean soil, rock, concrete, brick, other inert materials, and bituminous asphalt when placed at least 4 feet above the water table. Mixtures of soil and vegetation, that are primarily soil, may also be placed in non-permitted disposal areas. Place all other debris in sites that have been permitted by the Solid Waste Management Division of the North Carolina Department of Environment and Natural Resources unless otherwise permitted.

Maintain the earth surfaces at all waste areas in a manner that will effectively control erosion and siltation until final acceptance of the project.

Shape the waste or disposal area to drain such that no water will collect or stand. Provide a functioning drainage system.

Shape rock and earth waste to contour and blend with the adjacent topography. Cover all rock, concrete, broken pavement and masonry with a minimum 6" thick layer of earth material from the project or borrow. Earth material should be tested to insure it will support long-term growth of the proposed ground cover and should be amended as necessary to support permanent growth. As an exception, side slopes constructed of all rock material will not require earth covering. Construct all slopes, other than rock, 2:1 or flatter. Construct rock slopes on a stable angle of repose.

Where the Engineer has granted permission to dispose of waste within the right of way, the Engineer will have the authority to establish whatever additional requirements may be necessary to insure the satisfactory appearance and drainage of the completed project.

Where electing to dispose of waste or debris in active public waste or disposal sites, provide evidence satisfactory to the Engineer that the Solid Waste Management Division of the North Carolina Department of Environment and Natural Resources has permitted the proposed area or site.

Where electing to dispose of waste in a waste or disposal area, other than active public waste or disposal areas that have been permitted by the Solid Waste Management Division of the North Carolina Department of Environment and Natural Resources or on the Department's right-of-way or an existing borrow pit, submit jointly with the property owner a notarized Development, Use, and Reclamation Plan for each waste or disposal area proposed for use. As part of the Reclamation Plan, perform the following prior to wasting:

(A) Material Description

Detail the type of waste material proposed in the area. Only material originating from the Department's projects and complying with the requirements of the Solid Waste Disposal Act will be permitted within the proposed waste or disposal area.

(B) Topography

Detail the existing topography and locations of the proposed access and egress haul roads. Detail the proposed final topography of the waste or disposal area showing any proposed drainage systems. If a pond is to be constructed or remain, the minimum depth shall be at least 4 feet as determined from the water table at the time the reclamation plan is executed. The slope of the soil below the water shall be between 5:1 and 2:1. The slope of the sides above the water line shall be 2:1 or flatter.

(C) Slopes

Rock and earth waste shall be shaped to contours that are compatible to and blend with the adjacent topography. Cover all rock with a minimum 6" layer of earth material either from project waste or from borrow. As an exception, side slopes constructed of all rock material will not require earth covering. Construct all slopes at a 2:1 or flatter except rock slopes that shall be on a stable angle of repose.

(D) Construction Debris

Cover construction debris and all broken pavement and masonry with a minimum 6" thick layer of earth waste material from the project or borrow. Shape the completed waste area as required above for the disposal of earth or rock waste.

(E) Erosion Control

Detail the temporary and permanent erosion control measures, along with design calculations, that are intended during use of the site and as part of the reclamation. Unless considered impractical due to special circumstances, provide in the plan for the use of staged permanent seeding and mulching and appropriate fertilizer topdressing on a continual basis during site use and the immediate total reclamation of the site when the site is no longer needed. Define the seed mixture proposed for establishing temporary and/or permanent vegetation. Establish permanent stand of vegetation prior to acceptance of project.

(F) Evaluation for Potential Wetlands and Endangered Species

Hire an experienced environmental consultant on the Department's approved list to perform an assessment of the waste site for potential conflicts with wetlands, Areas of Environmental Concern (CAMA), federally listed threatened or endangered species, and federal species of concern.

Delineate the boundaries of any wetlands or jurisdictional surface waters (streams) encountered. Follow the standard practice for documenting the wetland delineation including completion of the Army Corps of Engineer's approved *wetland data form*. Document information including data regarding soil, vegetation and hydrology. Maintain a minimum 25 foot buffer adjacent to all sides of the wetland boundary and a minimum 50 foot buffer adjacent to any stream. Depict the limits of the delineated wetland and surrounding buffer on the Reclamation Plan. Do not dispose of waste and debris in any area under the Corps of Engineers' or any other environmental agencies' regulatory jurisdiction unless and until the NCDOT permit has been modified to permit such disposal activity in the jurisdictional area.

Perform a site assessment for federally listed threatened or endangered species to include habitats that may support these species. Provide to the Engineer a detailed report on the assessment findings. If federally listed threatened or endangered species or habitat that may support such species exist on the proposed waste site, notify the Engineer prior to continued pursuit of such site.

(G) Buffer Zones

Allocate sufficient area between the nearest property line and the tie-in of the slope to natural ground to allow for the operation of excavation, hauling, and seeding equipment and for the installation of any and all erosion control devices required. Leave additional undisturbed area between the source and any watercourse or body to prevent siltation of the watercourse or body and the movement of the shore line either into the watercourse or body or into the waste areas. Determine if the adjoining property owners or other government agencies require any additional buffer zones and comply with those requirements. [Suggested minimum distances

are 10’ from property lines and 50’ from water bodies or watercourses.] Do not place waste material within the 100-year floodplain unless superseded by an environmental permit.

(H) Approval

Obtain written approval from the Engineer prior to wasting within the proposed waste or disposal area.

Submit a revised or additional reclamation plan if the non-permitted waste or disposal area is expanded by more than one acre or is significantly changed from the previously approved submittal.

802-3 MEASUREMENT AND PAYMENT

Seeding and mulching, fertilizer topdressing, and *establishing erosion control measures for waste or disposal areas* will be measured and paid for at the contract unit prices for the items established in the contract.

When permitted to waste within the right of way and when the waste area requires additional covering material before seeding, provide covering material at no cost to the Department.

When waste areas are located outside the right of way, no payment will be made for any borrow used to cover rock, broken pavement, masonry, or other inert materials.

Except as otherwise provided above, no direct payment will be made for the work covered by this section. Payment at the contract prices for the various items in the contract will be full compensation for all work covered by this section.

SECTION 806
RIGHT OF WAY MARKERS

806-1 DESCRIPTION

Furnish and install precast concrete or granite markers to mark the boundaries of the right of way in accordance with the requirements of the contract.

806-2 MATERIALS

Refer to Division 10

Item	Section
Right of Way Markers	1054-1

The Contractor may, at his option, use either granite or concrete right of way markers.

806-3 CONSTRUCTION METHODS

Install the markers vertically in the ground to the depth and locations specified in the contract. Thoroughly tamp backfill material.

806-4 MEASUREMENT AND PAYMENT

Right of Way Markers will be measured and paid for in units of each for the actual number of right of way markers that have been furnished, installed, and accepted.

Payment will be made under:

Pay Item	Pay Unit
Right of Way Markers	Each

SECTION 808
OBLITERATION OF EXISTING ROAD

808-1 DESCRIPTION

The work covered by this section consists of the obliteration of an existing road outside of the construction limits.

808-2 CONSTRUCTION METHODS

Remove any existing pavement as directed. Fill or grade and shape the entire roadway to a degree that will blend with the adjacent topography and suitable for the application of vegetative cover.

808-3 MEASUREMENT AND PAYMENT

Removal of Existing Asphalt Pavement will be measured and paid for in accordance with the requirements of Article 250-3. The work includes but is not limited to all breaking up, removing, and disposing of pavement; all plowing of the roadbed; all grading and excavation necessary to reshape the roadway.

Removal of Existing Concrete Pavement will be measured and paid for in accordance with the requirements of Article 250-3. Such price includes, but is not limited to all breaking up, removing, and disposing of pavement; all plowing of the roadbed; all grading and excavation necessary to reshape the roadway.

All materials excavated in obliterating the abandoned roadway will be paid for at the contract price for *Unclassified Excavation* in accordance with the requirements of Article 225-7.

Any additional material that is required to complete the reshaping of the roadway will be paid for at the contract unit price for *Unclassified Excavation* in accordance with the requirements of Article 225-7, or at the contract unit price for *Borrow Eexcavation* in accordance with the requirements of Article 230-5, depending on the source of the material.

All seeding and mulching performed on obliterated areas will be paid for at the contract unit prices for the items established in the contract.

SECTION 815
SUBSURFACE DRAINAGE

815-1 DESCRIPTION

Construct underdrains, blind drains, or other types of subsurface drain except shoulder drains, and furnish and install painted pavement markers and vertical markers to locate concrete pads for the drains in accordance with the requirements of the contract.

815-2 MATERIALS

Refer to Division 10

Item	Section
Subdrain Fine Aggregate	1044-1
Concrete Pipe and Fittings	1044-3
Corrugated Steel Pipe and Fittings	1044-4
Polyvinyl Chloride Plastic (PVC) Pipe	1044-5
Outlet Pipe	1044-7
Corrugated Plastic Pipe and Fittings	1044-6
Portland Cement Concrete	1000
Pavement Markers Paint	1087
Steel Marker	1072-4
Steel Marker Paint	1080-14

Subsurface drainage pipe and fittings may be either concrete, corrugated steel or corrugated plastic.

815-3 CONSTRUCTION METHODS

Excavate the trench to the width shown on the plans, and to the depth, line and grade established by the Engineer.

Lay perforated pipe with the perforations down except for when subsurface water is to be passed through dry materials, turn up the perforations or use non-perforated pipe. When concrete pipe is used and subsurface water is to be passed through dry materials, make mortar joints in accordance with the requirements of Article 300-6.

Firmly join together corrugated steel pipe sections by coupling bands or other approved mechanical methods.

After the pipe has been laid, carefully place the backfill material so that the pipe will not be disturbed by the backfilling operation. Firmly tamp all earth backfill material.

Outlet pipe shall meet the requirements of Article 1044-7. Solvent cement the SCH-40 pipe and fittings together. Connect the HDPE pipe with watertight neoprene connectors that are suitable for gravity flow conditions. Provide connectors for all pipe fittings that are suitable for gravity flow conditions. Obtain approval for all pipe fittings from the Engineer prior to delivery. Protect the open end of all outlet pipes with a galvanized rodent screen as shown in plans.

Where pipe is not placed in a trench, place the amount of subdrain fine aggregate material over and around the pipe as shown on the plans.

Connect the subdrains to existing drainage structures or to concrete pads at the outlet end of the subdrain. Construct the concrete pad in accordance with Section 825 and give an ordinary surface finish. Use Class B concrete.

Furnish and install steel markers in accordance with the plans and use at all concrete pads. Install pavement markers as detailed in the plans at all concrete pads.

815-4 MEASUREMENT AND PAYMENT

Subdrain Excavation will be measured and paid for as the actual cubic yards measured in its original position that has been excavated within the authorized pipe trench limits. The authorized trench width will be the width shown on the plans or as directed. The authorized trench depth will be the depth established by the Engineer.

Subdrain Fine Aggregate will be measured and paid for as the actual number of cubic yards , measured in place within authorized limits, that has been used as backfill. The authorized trench limits will be the same as those limits used in the measurement of excavation. Where the subdrain fine aggregate has not been placed in a trench, measurement will be based on the dimensions established by the Engineer.

__ *" Perforated Subdrain Pipe* will be measured and paid for in linear feet of pipe that has been incorporated into the completed and accepted work. Measurement will be made along the pipe installation, excluding fittings, to the nearest 0.1 foot .

___*" Outlet pipe* will be measured and paid for in linear feet of pipe that has been incorporated into the completed and accepted work. Measurement will be made along the pipe installation, excluding fittings, to the nearest 0.1 foot.

Subdrain Wyes, Tees, and *Elbows* will be measured and paid for per each for the actual number of these fittings that have been incorporated into the completed and accepted work.

Concrete Pads for Subdrain Pipe Outlet will be measured and paid for per each for the actual number of pads that have been completed and accepted.

Such price and payment includes, but is not limited to furnishing, hauling, and placing all pipe, fittings, subdrain fine aggregate, concrete, and other materials; making all joint connections; cutting into and making connections to existing drainage structures; removing existing paved ditches; grouting around the pipe where it enters existing drainage structures; pavement and vertical markers; and all excavation and backfilling.

Payment will be made under:

Pay Item	**Pay Unit**
Subdrain Excavation	Cubic Yard
Subdrain Fine Aggregate	Cubic Yard
__" Perforated Subdrain Pipe	Linear Foot
__" Outlet Pipe	Linear Foot
__" Subdrain Pipe Wyes, Tees, and Elbows	Each
Concrete Pad for Subdrain Pipe Outlet	Each

SECTION 816
SHOULDER DRAINS

816-1 DESCRIPTION

Construct shoulder drains and furnish and install painted pavement markers and vertical markers to locate concrete pads for the drains in accordance with the requirements of the contract.

816-2 MATERIALS

Refer to Division 10

Item	Section
Shoulder Drain Aggregate, No. 57 Stone	1005
Concrete Pipe and Fittings	1044-3
Corrugated Steel Pipe and Fittings	1044-4
Polyvinyl Chloride Plastic (PVC) Pipe	1044-5
Corrugated Plastic Pipe and Fittings	1044-6
___ " Outlet Pipe	1044-7
Shoulder Drain Filter Fabric, Type 1	1056
Portland Cement Concrete, Class B	1000
Pavement Marker Paint	1087
Steel Marker	1072-4
Steel Marker Paint	1080-14

Material for shoulder drain pipe and fittings may be concrete, corrugated steel, or corrugated plastic.

816-3 CONSTRUCTION METHODS

Excavate the trench to the width, depth, lines, and grades shown on the plans unless otherwise directed.

Do not leave fabric uncovered for more than 7 days. Install filter fabric such that all splice joints are provided with a minimum overlap of 2 feet . Overlap the closure at the top of the trench at least 6 " and secure with mechanical ties. Where outlet pipe passes through the fabric, wrap a separate piece of fabric around the outlet pipe, flare against the side of the filled drain, and secure with anchor pins.

Anchor field splices of filter fabric with anchor pins to ensure that required overlap is maintained.

Perform aggregate placement operations and the pipe installation to prevent damage to the filter fabric. Replace damaged sections of filter fabric at no cost to the Department.

Firmly join together corrugated steel pipe sections with coupling bands or with a smooth sleeve type coupler, or with other approved mechanical methods.

Outlet pipe shall meet the requirements of Article 1044-7. Solvent cement the SCH-40 pipe and fittings together. Connect the HDPE pipe with watertight neoprene connectors that

are suitable for gravity flow conditions. Obtain approval for all pipe fittings from the Engineer prior to delivery. Protect the open end of all outlet pipes with a galvanized rodent screen as shown in plans. When the pipe perforations are not distributed uniformly over the circumference of the pipe, lay perforated pipe with the perforated segments of the pipe down. When plain pipe is called for by the plans, turn the perforations up or use non-perforated pipe.

Where pipe is not placed in a trench install the amount of subdrain fine aggregate material over and around the pipe as shown on the plans.

Install outlet fittings and outlet pipes with aggregate shoulder drains. Establish positive drainage within 72 hours of beginning trenching for installation of a given section of aggregate shoulder drain. Failure to comply with this requirement may result in the Engineer restricting installation of additional sections of aggregate shoulder drain until such time as the Contractor completes appropriate outlet installations.

Compact the aggregate to a degree acceptable to the Engineer by the use of a vibratory compactor before making the filter fabric closure at the top of the trench.

Carefully place the backfill material after the pipe has been laid, so that the pipe will not be disturbed by the backfilling operation. Firmly tamp all earth backfill material.

Connect the shoulder drains to existing drainage structures or to concrete pads at the outlet end of the subdrain. Construct the concrete pad in accordance with Section 825 and give an ordinary surface finish. Use Class B concrete.

Furnish and install steel markers in accordance with the plans and use at all concrete pads. Install pavement markers as detailed in the plans at all concrete pads.

816-4 MEASUREMENT AND PAYMENT

Shoulder Drain will be measured and paid as the actual number of linear feet that has been completed and accepted, measured to the nearest foot along the centerline of the completed shoulder drain aggregate. No measurement will be made along the outlet pipe.

__ *" Shoulder Drain Pipe* will be measured and paid for in linear feet of all pipe that has been incorporated into the completed and accepted work. Measurement will be made along the pipe installation, including fittings, to the nearest 0.1 foot with no deduction made for fittings.

__ *" Outlet Pipe for Shoulder Drain* will be measured and paid for in linear feet of all pipe that has been incorporated into the completed and accepted work. Measurement will be made along the pipe installation, including fittings, to the nearest 0.1 foot with no deduction made for fittings.

Concrete Pad for Shoulder Drain Pipe Outlet will be measured and paid for in units of each for the actual number of pads that have been completed and accepted.

Such price and payment includes but is not limited to furnishing, hauling, and placing all pipe, fittings, shoulder drain aggregate, filter fabric, concrete, and other materials; making all joint connections; cutting into and making connections to existing drainage structures; grouting around the pipe where it enters existing drainage structures; pavement and vertical markers and all excavation and backfilling.

Payment will be made under:

Pay Item	Pay Unit
Shoulder Drain	Linear Foot
__ " Shoulder Drain Pipe	Linear Foot
__ " Outlet Pipe for Shoulder Drain	Linear Foot
Concrete Pad for Shoulder Drain Pipe Outlet	Each

SECTION 818
BLOTTING SAND

818-1 DESCRIPTION

Furnish and uniformly spread the blotting sand, as directed to prime coat, asphalt surface treatment, or asphalt curing seal.

818-2 MATERIALS

Refer to Division 10

Item	Section
Blotting Sand	1012-3

818-3 CONSTRUCTION METHODS

Apply blotting sand upon completion of the asphalt application, when directed. Provide relatively dry blotting sand. Spread uniformly, as directed, on the same day as the application of prime coat, asphalt surface treatment, or asphalt curing seal. Apply at the rate of 10 pounds per square yard of surface area unless otherwise directed.

818-4 MEASUREMENT AND PAYMENT

Blotting Sand will be measured and paid for in tons that have actually been placed. The quantity will be measured by weighing in trucks on certified platform scales or other certified weighing devices. No deduction will be made of any moisture in the sand at the time of weighing. No measurement of blotting sand will be made when the blotting sand is part of a Drag Seal or a Sand Seal.

Payment will be made under:

Pay Item	Pay Unit
Blotting Sand	Ton

SECTION 820
FUNNELS AND FUNNEL DRAINS

820-1 DESCRIPTION

Furnish and install all funnels, pipe, elbows and all other materials in accordance with the requirements of the contract.

820-2 MATERIALS

Refer to Division 10

Item	Section
Funnels	1054-4(A)
Funnel Drain Pipe	1054-4(B)
Funnel Drain Pipe Elbows	1054-4(B)
Portland Cement Concrete, Class B	1000

Use connector rings with gaskets in accordance with manufacturer's recommendations that are designed to form a properly sealed joint and provide circumferential and longitudinal strength sufficient to preserve the alignment and prevent separation of the sections

820-3 CONSTRUCTION METHODS

Furnish concrete, install and anchor funnel, and place connector ring with gaskets in accordance with the details in the plans and in accordance with manufacturer's recommendations so that the water will flow freely into it without overflow or leakage. Securely join the funnel drain pipe to the funnel and backfill with sufficient care so that no part of the funnel or funnel drain pipe is displaced or moved out of alignment. Place backfill material in 6" layers and compact to a density comparable to the adjacent undisturbed material.

Construct a temporary construction berm to divert runoff into the funnel until paved ditch, paved berm or curb is constructed.

820-4 MEASUREMENT AND PAYMENT

Metal Funnels will be measured and paid for in units of each for the actual number of funnels that have been installed and accepted. No separate payment will be made for the concrete, and the connector ring with gaskets as such work will be included in the contract unit price each for metal funnels.

__ *" Funnel Drain Pipe* will be measured and paid for as the actual number of linear feet of pipe that has been incorporated into the completed and accepted work. Measurement will be made by counting the number of joints used and multiplying the length of the joint. Where partial joints are used, measurement will be made along the longest length of the partial joint to the nearest 0.1 foot .

__ *" Funnel Drain Pipe Elbows* will be measured and paid for in units of each for the actual number of elbows that have been installed and accepted.

Such price and payment includes but is not limited to metal funnels, funnel drain pipe and elbows, all excavation and backfilling, and construction and maintenance of temporary berms for diversion in accordance with the requirements of the contract.

Payment will be made under

Pay Item	Pay Unit
Metal Funnels	Each
__" Funnel Drain Pipe	Linear Foot
__" Funnel Drain Pipe Elbows	Each

SECTION 825
INCIDENTAL CONCRETE CONSTRUCTION - GENERAL

825-1 DESCRIPTION

This section consists of the general requirements for the construction of all incidental concrete construction. The provisions of Sections 838, 840, 846, 848, 850, 852, 853, 854, 855, 857, and 858 will prevail over any conflicting requirements of this section.

825-2 FORMS

(A) General

Maintain forms true to the required lines, grades and dimensions. Construct forms with material of such strength and with sufficient rigidity to prevent any appreciable deflection between supports. Provide mortar-tight forms with a fillet at sharp corners when indicated on the plans.

Design clamps, pins, and metal spacers, anchorages, and other connecting devices to hold the forms rigidly together. Construct or install any metal spacers or anchorages that are required within the forms so that the metal work can be removed to a depth of at least 1 " from the exposed surface of the concrete without injury to the surface. The recess thus formed in the concrete shall have a diameter not greater than 1 ½ times the depth.

Maintain the shape, strength, rigidity, and surface smoothness of forms that are to be re-used at all times. Thoroughly clean all dirt, mortar, and foreign material from forms before reusing. Thoroughly coat all inside form surfaces with commercial quality form oil or other equivalent coating before placing concrete.

(B) Wood Forms

Provide forms with a smooth and uniform texture. Make joints between forms tight and even so that no appreciable form marks remain after the forms are removed.

Do not use plywood sheets showing torn grain, worn edges, patches, or other defects that impair the texture of concrete surfaces that will be exposed to view.

(C) Metal Forms

Use metal forms of such thickness and rigidity that the forms will remain true to shape. Counter-sink bolt and rivet heads. Use only metal forms that present a smooth surface and line up properly. Keep metal forms free from all foreign matter that will discolor the concrete.

825-3 REINFORCEMENT

Furnish and place reinforcement as shown on the plans and in accordance with the requirements of Section 425.

825-4 PLACING CONCRETE

Do not place concrete until the foundation, the adequacy of the forms, the placing of reinforcement and other embedded items have been inspected and approved.

Place concrete in daylight unless an approved lighting system is provided.

Remove all debris from the interior of forms in preparation for placing concrete. Moisten earth or base course surfaces on which concrete is to be placed immediately before placing concrete. Do not place concrete on excessively wet or frozen surfaces.

Place concrete in its final position in the forms within the time stipulated in Subarticle 1000-4(E).

Place concrete so as to avoid segregation of the materials and the displacement of the reinforcement. Thoroughly work the concrete during placement. Bring mortar against the forms to produce a smooth finish, substantially free from water and air pockets or honeycombs.

Do not place concrete when the air temperature, measured at the location of the concrete operation in the shade away from artificial heat, is below 35°F unless permission is otherwise granted. When such permission is granted, uniformly heat the aggregates and water to a temperature no higher than 150°F. Place the heated concrete at a temperature of not less than 55°F and not more than 80°F.

825-5 SLUMP TESTS

Test the slump of the concrete in accordance with Article 420-6.

825-6 FINISHING

(A) General

Provide the type of finish required by the contract directly applicable to the work being constructed.

(B) Ordinary Surface Finish

Remove all form ties or metal spacers to a depth of at least 1" below the surface of the concrete and clean and fill the resulting holes or depressions with grout. Metal devices with exposed cross sectional area not exceeding approximately 0.05 square inch on surfaces permanently in contact with earth fill may be broken off flush with the surface of the concrete.

Remove all fins caused by form joints and other projections. Remove stains and discoloration. Clean all pockets and fill with grout as directed. Thoroughly soak the surface of all concrete with water prior to the application of a grout repair.

Use grout consisting of one part cement and two parts sand. Use cement from the same source as originally incorporated in work. Cure the grout for at least 3 days. After the grout has thoroughly hardened, rub the patch with a carborundum stone as required to match the texture and color of the adjacent concrete.

On surfaces that are to be backfilled or surfaces that are enclosed, the removal of form marks, fins, and pockets; the rubbing of grouted areas to uniform color; and the removal of stains and discoloration will not be required.

(C) Sidewalk Finish

Strike off fresh concrete and compact until a layer of mortar is brought to the surface. Finish the surface to grade and cross section with a float, trowel smooth, and finish with a broom.

(D) Rubbed Finish

After the ordinary surface finish has been completed, thoroughly wet and rub the entire surface. Use a coarse carborundum stone or other equally good abrasive to bring the surface to a smooth texture and remove all form marks. Finish the paste formed by rubbing by carefully stroking with a clean brush, or spread the paste uniformly over the surface and allow it to take a reset. Finish by floating with a canvas, carpet-faced, or cork float; or rub down with dry burlap.

(E) Float Finish

Finish the surface with a rough carpet float or other suitable device leaving the surface even, but distinctly sandy or pebbled in texture.

825-7 REMOVING FORMS

Do not remove forms from freshly placed concrete until it has hardened sufficiently to resist spalling, cracking, or any other damage.

825-8 PROTECTION FROM COLD WEATHER

When it is anticipated that the atmospheric temperature will fall below 35°F, protect concrete in accordance with Subarticle 420-7(C). Protect concrete containing fly ash or ground granulated blast furnace slag for a minimum of 7 curing days, and all other concrete for a minimum of 3 curing days.

825-9 CURING

Cure concrete in accordance with Subarticle 700-9(B) immediately after finishing operations are completed and surface water has disappeared. Where forms are removed before the expiration of the required curing period, apply the curing compound immediately after the forms are removed.

Cure each mass for a period of 7 curing days. A curing day is any consecutive 24 hour period, after finishing operations of the mass is completed, when the air temperature adjacent to the mass does not fall below 40°F.

825-10 JOINTS

(A) General

Construct joints at right angles to the surface of the concrete. Locate joints at right angles to the longitudinal centerline of curb, curb and gutter, gutter, island, median, median barrier, and all paved areas, except where different joint locations are called for on the plans.

Where concrete is to be placed adjacent to any existing slab or pavement that has a broken or irregular edge, provide a reasonably vertical edge by sawing.

(B) Grooved Contraction Joints

Form grooved contraction joints by a tool specifically constructed for this purpose, or by sawing with an approved concrete saw.

Groove contraction joints to the depth shown on the plans and to a width between 1/4 " and 1/2" , unless otherwise shown on the plans. If formed by a tool, make a radius of 1/8" at the corners of the adjacent concrete.

(C) Expansion Joints

Fill construction joints with an expansion joint filler. Cut the filler into the shape necessary to fill the joint. Make the filler 1/2" thick unless indicated otherwise on the plans. After the concrete has hardened cut the filler away to a depth of 1/2" to provide space for the joint sealer.

Install an expansion joint adjacent to any existing slab, pavement, or structure against which new concrete is placed and at other locations detailed in the plans.

(D) Construction Joints

Construct construction joints as shown on the plans, or where otherwise approved.

(E) Sawing Joints

Saw joints after the concrete has hardened sufficiently to be sawed without spalling and raveling but not more than 24 hours after the concrete has been placed.

(F) Sealing Joints

Seal all contraction and expansion joints, except otherwise specified, before the backfill is placed.

Thoroughly clean the joint to remove all foreign matter. Dry joints before sealing.

Entirely fill joints to within 1/8" to 1/4" of the surface of the concrete with joint sealer. Immediately remove any sealer spilled on the surface of the concrete.

Place joint sealer with equipment meeting the specifications of the manufacturer of the sealer material.

825-11 MEASUREMENT AND PAYMENT

There will be no direct payment for the work covered by this section.

Payment at the contract prices for the various items covered by those sections of the Specifications directly applicable to the work being constructed will be full compensation for all work covered by this section.

SECTION 828
TEMPORARY STEEL COVER FOR MASONRY DRAINAGE STRUCTURE

828-1 DESCRIPTION

Install temporary steel plate covers on masonry drainage structures in accordance with the details shown in the plans and as directed.

828-2 MATERIALS

Provide materials that are Grade A36 steel and the size and thickness shown on the detail in the plans.

828-3 MEASUREMENT AND PAYMENT

Temporary Steel Plate Covers for Masonry Drainage Structures will be measured and paid for in units of each for the actual number of these items that have been incorporated into the completed and accepted work.

Payment will be made under:

Pay Item	Pay Unit
Temporary Steel Plate Covers for Masonry Drainage Structures	Each

SECTION 830
BRICK MASONRY CONSTRUCTION - GENERAL

830-1 DESCRIPTION

This work consists of the general requirements for all nonreinforced brick masonry construction. The provisions of Sections 453, 838, 840 and 858 will prevail over any conflicting provisions of this section.

830-2 CONSTRUCTION METHODS

Construct all concrete footings and all other concrete elements of the structure in accordance with Section 825.

830-3 MORTAR

Use freshly mixed mortar meeting the requirements of Article 1040-8. All mortar that has developed initial set or lost plasticity will be rejected.

830-4 LAYING BRICK

Dampen brick when necessary to reduce the rate of absorption. Build brick masonry plumb and true to the required dimensions. Place a header course approximately mid height

of the structure in structures less than 9 courses high. Place a header course every third course on structures 9 courses high or higher. Use other types of bonding where indicated on the plans.

Completely fill brick joints and cavities with mortar. The thickness of mortar joints is a maximum 5/8" and a minimum of 3/8" except where otherwise indicated on the plans. Finish joints that will remain exposed after backfill with a concave jointer. Flush cut all other joints.

Use spalls or bats only when shaping around irregular openings or when unavoidable to finish out a course. Place a full brick at the corner and place the bat in the interior of the course when necessary to finish out the course.

Clean spilled mortar from exposed exterior surfaces not backfilled.

830-5 PROTECTION FROM COLD WEATHER

Do not place masonry when the temperature is below 35°F unless adequate protection is provided by a pre-approved method.

When it is anticipated that the atmospheric temperature will fall below 35°F protect masonry, in accordance with Subarticle 420-8(C), for a minimum of 3 curing days.

A curing day is considered any consecutive 24 hour period, beginning when the last masonry unit is placed in the completed structure, during which the air temperature adjacent to the structure does not fall below 40°F.

830-6 MEASUREMENT AND PAYMENT

There will be no direct payment for the work covered by this section.

Payment at the contract prices for the various items covered by those sections of the Specifications directly applicable to the work being constructed will be full compensation for all work covered by this section.

SECTION 832
REINFORCED BRICK MASONRY CONSTRUCTION - GENERAL

832-1 DESCRIPTION

This work shall consist of the general requirements for all reinforced brick masonry construction. The requirements of Section 838 will prevail over any conflicting provisions of this section.

832-2 CONCRETE CONSTRUCTION

Construct concrete footings and all other concrete elements of the structure in accordance with Section 825. Furnish and place reinforcement as shown on the plans and in accordance with the requirements of Section 425. Use Class A concrete for footings unless otherwise indicated on the plans. Use Class M concrete in reinforcement cavities. Rod Class M concrete to provide a dense, homogeneous concrete. Do not vibrate.

832-3 MORTAR

Machine mix mortar, meeting the requirements of Article 1040-8 for not less than 1 1/2 minutes. Remove and dispose of any mortar that has developed initial set or lost plasticity.

832-4 LAYING BRICK

Dampen brick when necessary to reduce the rate of absorption. Construct the type of bond called for on the plans. Build reinforced brick masonry plumb and true to the required dimensions.

Lay brick with completely filled mortar joints. Make mortar joints not more than 1/2" or less than 1/4" thick except where indicated on the plans. Finish joints that will remain exposed after backfill, with a concave jointer. Flush cut all other joints.

Use spalls or bats only when shaping around irregular openings. Place a full brick at the corner and place the bat in the interior of the course when necessary to finish out a course.

Clean spilled mortar from exposed exterior surfaces not backfilled.

832-5 PROTECTION FROM COLD WEATHER

Refer to Article 830-5

832-6 MEASUREMENT AND PAYMENT

There will be no direct payment for the work covered by this section.

Payment at the contract unit prices for the various items covered by those sections of the Specifications directly applicable to the work being constructed will be full compensation for all work covered by this section.

SECTION 834
BLOCK MASONRY
CONSTRUCTION - GENERAL

834-1 DESCRIPTION

This work consists of constructing concrete block masonry. The requirements of Sections 840, 858 and 859 will prevail over any conflicting provisions of this section.

834-2 CONCRETE CONSTRUCTION

Construct concrete footings and all other concrete elements of the structure in accordance with Section 825. Use Class B concrete unless otherwise indicated on the plans.

834-3 MORTAR

Use freshly mixed mortar meeting the requirements of Article 1040-8. Remove and dispose of any mortar that has developed initial set or has lost plasticity.

834-4 LAYING CONCRETE BLOCK

Build block masonry plumb and true to the required dimensions. Stagger vertical joints. Set the block with the cells vertical. Spread mortar on the bearing members and fill the vertical joints with mortar. Dampen block when necessary to reduce the rate of absorption.

Make joints straight, level, plumb, and neat at intersection. Make joints 1/4 to 1/2" thick except where otherwise indicated on the plans. Finish joints that will remain exposed after backfill, with a concave jointer. Flush cut all other joints. Clean exposed exterior surfaces of spilled mortar that are not backfilled.

834-5 PROTECTION FROM COLD WEATHER

Refer to Article 830-5.

834-6 COMPENSATION

There will be no direct payment for the work covered by this section.

Payment at the contract prices for the various items covered by those sections of the Specifications directly applicable to the work being constructed will be full compensation for all work covered by this section.

SECTION 838
ENDWALLS

838-1 DESCRIPTION

Perform the work covered by this section including but not limited to excavation, hauling, disposal of materials, furnishing and placing backfill materials, subsurface drainage, concrete, brick masonry, mortar, grout, and furnishing and placing reinforcing steel in order to construct portland cement concrete or brick masonry endwalls, either plain or reinforced, in accordance with the requirements shown on in the contract.

838-2 MATERIALS

Refer to Division 10:

Item	Section
Portland Cement Concrete, Class B	1000
Curing Agents	1026
Brick	1040-1
Mortar	1040-8
Reinforcing Steel	1070-2
Subdrain Fine Aggregate	1044-1
Stone, No 78M	1005
Precast Concrete Units	1077
Select Material	1016

Use portland concrete, brick masonry or precast concrete for the endwall unless otherwise specified on the plans.

If precast sections are proposed, submit in writing for approval.

838-3 CONSTRUCTION METHODS.

(A) Foundation:

Do not place concrete or masonry until the foundation is approved.

Excavate foundation to a firm surface, make level or stepped, and clean surfaces of loose material. Make excavation true to lines and dimensions shown on plans.

Where the foundation material is found to be of poor supporting value or of rock, the Engineer may make minor adjustments in the location of the structure to provide a more suitable foundation. Where this is not practical, undercut the foundation and condition by backfilling with an approved select material.

(B) Concrete and Masonry:

Construct concrete in accordance with Section 825 and give an ordinary surface finish. Construct brick masonry in accordance with Sections 830 and 832. Furnish and place reinforcing steel in accordance with Section 425.

Provide the class of concrete indicated on the plans.

Obtain approval if field conditions necessitate a variance from the plan dimensions of the structure and footings.

Construct endwalls on the end of a full joint of pipe and in accordance with the details in the plans.

Any endwall that incorporates an opening for circular pipe 54" or greater shall be reinforced.

(C) Backfill:

Complete endwall construction, and remove all forms. Backfill with approved material after the concrete or brick masonry has cured for at least 7 curing days unless otherwise permitted. A curing day is defined in Article 830-5. Within 4 calendar days after the completion of the seven day curing period, shape, compact, and complete backfill in accordance with the contract.

838-4 MEASUREMENT AND PAYMENT

Endwalls will be measured and paid for in cubic yards of cast in place concrete, brick, or precast concrete that has been completed and accepted. This quantity will be computed from the dimensions shown on the plans or from revised authorized dimensions.

Reinforced Endwalls will be paid for in cubic yards of reinforced cast in place concrete, reinforced brick or precast concrete that has been completed and accepted. This quantity will be computed from the dimensions shown on the plans or from revised authorized dimensions.

Payment will be made under:

Pay Item	Pay Unit
Endwalls	Cubic Yard
Reinforced Endwalls	Cubic Yard

SECTION 840
MINOR DRAINAGE STRUCTURES

840-1 DESCRIPTION

Perform the work covered by this section including but not limited to excavation; providing protection of employees in excavation; hauling; disposal of materials; removing existing pipe and drainage structures at the site of the work; furnishing, transporting, and placing foundation conditioning material, backfill material, subsurface drainage, concrete, brick masonry, block masonry, precast units, mortar, grout, reinforcing steel, hardware, castings, and miscellaneous metal; fabrication; welding; and galvanizing in order to construct cast-in-place concrete, brick masonry, block masonry, or precast concrete inlets, catch basins, junction boxes, spring boxes, manholes, concrete aprons, and other minor drainage structures excluding endwalls, with all necessary metal grates, covers, frames, steps, and other hardware, in accordance with the requirements of the contract.

Use cast-in place concrete, brick masonry, block masonry, or precast concrete construction as shown on approved plans.

840-2 MATERIALS

Refer to Division 10

Item	Section
Portland Cement Concrete, Class B	1000
Curing Agents	1026
Joint Fillers	1028-1
Joint Sealers	1028-2
Brick	1040-1
Concrete Block	1040-2
Mortar	1040-8
Precast Drainage Structure Units	1077
Reinforcing Steel	1070
Structural Steel	1072
Steps	1074-8
Fabricated Steel Grates	1074-9
Gray Iron Castings	1074-7
Select Materials	1016

Use grout in precast structures consisting of 1 part portland cement to 2 parts of mortar sand meeting the requirements of Articles 1040-4, 1040-6, and 1040-7.

Use foundation conditioning material meeting the requirements of Article 1016-3 for Class II, III, IV, V or VI select material as shown in the contract or as directed.

840-3 CONSTRUCTION METHODS

(A) Excavation

Perform excavation with equipment of adequate weight, size and capability. Where necessary, provide a competent person and protection of personnel in excavation by sloping, shoring or bracing in accordance with local, State or Federal standards and Article 107-1.

(B) Foundation

Do not place masonry drainage structure until the foundation has achieved adequate strength.

Where the foundation material is found to be of poor supporting value or of rock, minor adjustments in the location of the structure may be approved to provide a more suitable foundation. Where this is not practical, undercut the foundation and condition by backfilling with an approved select material.

Set precast foundation slabs to within plus or minus 1/2" of grade on a 2" to 3" thick bed of compacted foundation conditioning material.

(C) Cast-In-Place Concrete, Brick, and Block Masonry

Install drainage structures to plan line and grade or approved to meet drainage conditions. Do not modify the drainage structure by cobbling or use of concrete slabs unless otherwise directed.

Construct concrete in accordance with Section 825 and give an ordinary surface finish. Construct brick masonry in accordance with Section 830. Construct block masonry in accordance with Section 834. Furnish and place reinforcing steel in accordance with Section 425.

Do not modify box to adjust location.

Obtain approval if field conditions necessitate a variance from the plan dimensions of the structure and/ or footings.

(D) Installation of Precast Units

Install drainage structures to plan line and grade or approved to meet drainage conditions. Do not modify the drainage structure by cobbling or use of concrete slabs unless otherwise directed.

Assemble and grout together the precast drainage structure units in accordance with the manufacturer's instructions. Subarticle 840-3(C) applies where it is necessary to use cast-in-place concrete or brick masonry, or block masonry construction as part of the structure.

Obtain approval if field conditions necessitate a variance from the plan dimensions of the structure and/ or footings.

(E) Fittings and Connections

As the work is built up, accurately space, align, and thoroughly bond fittings that enter the structure.

Make pipe connections so that the pipe does not project beyond the inside wall of the drainage structure, and grout as necessary to make smooth and uniform surfaces on the inside of the structure.

Set metal frames for grates and covers in full mortar beds or secure by approved methods.

(F) Backfill

Complete drainage structure and remove all forms and falsework. Backfill with approved material, compacted to the density required by Subarticle 235-4(C), after the drainage structure has cured for at least 7 curing days, unless otherwise permitted. A curing day is defined in Article 825-9 for concrete or Article 830-5 for brick or block masonry.

(G) Pipe Collars and Pipe Plugs

Construct pipe collars and pipe plugs in accordance with the details shown in the plans or as directed.

Use any class of portland cement concrete contained within Section 1000 for pipe collars.

Construct pipe plugs with either brick masonry or any class of portland cement concrete contained within Section 1000.

(H) Concrete Aprons

Construct concrete aprons in accordance with the details in the plans. Use Class B or higher compressive strength concrete.

840-4 MEASUREMENT AND PAYMENT

Masonry Drainage Structure that incorporate an opening for circular pipe not exceeding 48" in diameter will be measured and paid for on an each basis, for the actual number completed and accepted.

Masonry Drainage Structure exceeding a height of 5.0 feet to be measured and paid for in linear feet for the portion of the drainage structure exceeding a height of 5.0 feet. The height will be measured vertically to the nearest tenth of a foot from the top of the bottom slab to the top of the wall.

Masonry Drainage Structures that incorporate an opening for circular pipe exceeding 48" in diameter, or for pipe arch of any size, will be measured and paid for on a volume basis as provided below.

Masonry to be paid for will be the number of cubic yards of cast-in-place concrete brick or block that has been incorporated into the completed and accepted structure. This quantity will be computed from the dimensions shown on the plans or from revised dimensions authorized by the Engineer. Where the wall thickness is greater than the wall thickness

shown on the plans due to the use of oversize brick or for any other reason, the wall thickness shown on the plans will be used to compute quantities except where an increase in wall thickness has been authorized by the Engineer.

Pipe Collars will be measured and paid for in cubic yards of concrete or brick that has been incorporated into the completed work. The cubic yards of pipe collars will be computed from the dimensions shown on the plans or from revised dimensions authorized by the Engineer.

Pipe Plugs will be measured and paid for in cubic yards of concrete or brick that has been incorporated into the completed and accepted pipe plug. The cubic yards of pipe plugs will be computed from the dimensions shown on the plans or from revised dimensions authorized by the Engineer.

Frame with Grate and Hood, Std. ___ will be measured and paid for in units of each for actual number of assemblies that have been incorporated into the completed work. No separate measurement will be made of grates, hoods, and covers that are part of the assembly, as the grates, hoods, and covers will be considered to be part of the complete assembly.

Frame with Grate, Std. ___ will be measured and paid for in units of each for actual number of assemblies that have been incorporated into the completed work. No separate measurement will be made of grates, hoods, and covers that are part of the assembly, as the grates, hoods, and covers will be considered to be part of the complete assembly.

Frame with Two Grates, Std. ___ will be measured and paid for in units of each for actual number of assemblies that have been incorporated into the completed work. No separate measurement will be made of grates, hoods, and covers that are part of the assembly, as the grates, hoods, and covers will be considered to be part of the complete assembly.

Frame with Cover, Std. ___ will be measured and paid for in units of each for actual number of assemblies that have been incorporated into the completed work. No separate measurement will be made of grates, hoods, and covers that are part of the assembly, as the grates, hoods, and covers will be considered to be part of the complete assembly.

Steel Frame with Two Grates, Std.__ will be measured and paid for in units of each for the actual number of fabricated steel grates that have been incorporated into the completed work.

Concrete Apron for catch basins and drop inlets will be considered incidental to the other work in this section. No separate payment will be made.

Foundation conditioning will be paid for as provided in Article 300-9.

The above prices and payments will be full compensation for all work covered by this section.

Payment will be made under:

Pay Item	Pay Unit
Masonry Drainage Structures	Each
Masonry Drainage Structures	Linear Foot
Masonry Drainage Structures	Cubic Yard
Pipe Collars	Cubic Yard
Pipe Plugs	Cubic Yard
Frame with Grate and Hood, Std._____	Each
Frame with Grate, Std._____	Each
Frame with Two Grates, Std._____	Each
Frame with Cover, Std._____	Each
Steel Frame with Two Grates, Std._____	Each

SECTION 846
CONCRETE CURB, CURB AND GUTTER, CONCRETE GUTTER, SHOULDER BERM GUTTER, CONCRETE EXPRESSWAY GUTTER AND CONCRETE VALLEY GUTTER

846-1 DESCRIPTION

Construct portland cement concrete curb, concrete curb and gutter, concrete gutter, shoulder berm gutter, concrete expressway gutter and 4" concrete valley gutter as shown in the contract.

846-2 MATERIALS

Refer to Division 10

Item	Section
Portland Cement Concrete, Class B	1000
Curing Agents	1026
Joint Fillers	1028-1
Joint Sealers	1028-2, 1028-4

846-3 CONSTRUCTION METHODS

(A) General

Construct concrete in accordance with Section 825, except as provided herein.

Give surface a light broom finish with brush marks parallel to the curb line or gutter line.

Prepare foundation and compact base or subgrade to the degree required by the applicable section of the Specifications before placing forms.

(B) Forms

Use forms that have no more than 1/8" in 10 feet deflection from true line horizontally and vertically to adequately support the concrete and construction equipment.

Obtain approval before placing concrete.

(C) Joints

Locate joints as shown on the plans except as provided herein.

Space joints no closer than 5 feet.

Locate joints to line up with the joints in concrete pavement when placed adjacent to concrete pavement.

Form grooved contraction joints as required by Subarticle 825-10(B).

Construct grooved butt joint between the work and adjacent pavement except where expansion joints are required by the plans. Form butt joints as required by Subarticle 825-10(B) for grooved contraction joints and seal.

Seal all joints except for joints in curb sections not having an integral gutter.

Fill joints in gutter with joint sealer to the top surface of the gutter.

Seal joints before backfilling or performing adjacent operations.

(D) Surface Tolerances

Finish surface within 1/4" when checked longitudinally with a 10 foot straightedge.

(E) Backfilling

Do not place backfill or pavement adjacent to the curb, curb and gutter, gutter, shoulder berm gutter, expressway gutter or concrete valley gutter until at least three curing days, as defined in Article 825-9, have elapsed.

Complete backfill within four calendar days after the completion of the three day curing period unless otherwise approved.

Compact backfill to an approved density.

(F) Opening to Traffic

Vehicles may be permitted on the completed work after the following curing days, as defined in Article 825-9, have elapsed:

Regular strength concrete -- seven curing days.

High early strength concrete -- three curing days.

846-4 MEASUREMENT AND PAYMENT

__ *" X __" Concrete Curb* will be measured and paid for by the linear foot , accepted in place, along the surface of the top of the curb.

__ *' __ " Concrete Curb and Gutter* will be measured and paid for by the linear foot, accepted in place. Measurement will be made along the surface of the top of the curb.

__ *' Concrete Gutter* will be measured and paid for by the linear foot accepted in place. Measurement will be made along the surface of the top of the curb.

Shoulder Berm Gutter will be measured and paid for by the linear foot, accepted in place. Measurement will be made along the surface of the top of the curb.

Concrete Expressway Gutter will be measured and paid for by the linear foot, accepted in place. Measurement will be made along the surface of the top of the curb.

Concrete Valley Gutter will be measured and paid for by the linear foot, accepted in place. Measurement will be made along the surface of the top of the curb.

Work includes providing all materials, placing all concrete, excavating and backfilling, forming, finishing, constructing and sealing joints, and all incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
__ " X __ " Concrete Curb	Linear Foot
__ ' __ " Concrete Curb and Gutter	Linear Foot
__ ' Concrete Gutter	Linear Foot
Shoulder Berm Gutter	Linear Foot
Concrete Expressway Gutter	Linear Foot
Concrete Valley Gutter	Linear Foot

SECTION 848
CONCRETE SIDEWALKS, DRIVEWAYS AND WHEELCHAIR RAMPS

848-1 DESCRIPTION

Construct portland cement concrete sidewalks, driveways, and wheelchair ramps in accordance with the requirements shown in the contract.

848-2 MATERIALS

Refer to Division 10

Item	Section
Portland Cement Cncrete, Class B	1000
Curing Agents	1026
Joint Fillers	1028-1
Joint Sealers	1028-2, 1028-4

Detectable Warnings may be either truncated dome concrete paving blocks or stamped concrete. Detectable warnings shall consist of raised truncated domes. Truncated Domes shall have a base diameter of no less than 0.9" to no more than 1.4", a top diameter of no less than 50% to no more than 65% of the base diameter, and a height of 0.2". Truncated domes shall have center-to-center spacing of no less than 1.6" to no more than 2.4", and a base to base spacing of 0.65" minimum, measured between the most adjacent domes on square grid.

848-3 CONSTRUCTION REQUIREMENTS

Where it is necessary to remove a portion of existing sidewalks or driveways, saw a neat edge along the pavement to be retained approximately 2" deep with a concrete saw before breaking the adjacent pavement away.

Construct concrete in accordance with Section 825 and give a sidewalk finish, except as otherwise provided herein.

Broom the concrete surface in a transverse direction to traffic. Make joint spacing no less than 5 feet. Where existing sidewalks are being widened, line up new transverse joints with existing joints in the adjacent sidewalk. Seal expansion joints where sidewalk and wheelchair ramps are placed adjacent to concrete curb and/ or gutter. Do not seal grooved joints.

Do not place backfill adjacent to the sidewalk, driveway or wheelchair ramp until at least 3 curing days, as defined in Article 825-9, have elapsed unless otherwise approved. Compact backfill to a degree comparable to the adjacent undisturbed material.

Do not place vehicles on the completed work until 7 curing days, as defined in Article 825-9, have elapsed. When high early strength concrete is used, vehicles will be permitted on the completed work after 3 curing days have elapsed.

Install detectable warnings 24" in length of truncated dome paving blocks along the bottom of the curb ramps in accordance with the plans and details. Obtain 70 percent contrast visibility with adjoining surfaces, either light-on-dark, or dark-on-light sequence covering the entire ramp.

848-4 MEASUREMENT AND PAYMENT

__" *Concrete Sidewalk* will be measured and paid for in square yards, measured along the surface of the completed and accepted work. Such price includes, but is not limited to excavating and backfilling, sawing the existing sidewalk, furnishing and placing concrete, and constructing and sealing joints.

__" *Concrete Driveways* will be measured and paid for in square yards, measured along the surface of the completed and accepted work. Such price includes, but is not limited to excavating and backfilling, sawing the existing driveway, furnishing and placing concrete, and constructing and sealing joints.

Concrete Wheelchair Ramps will be measured and paid for in units of each. Such price includes, but is not limited to excavating and backfilling, sawing the existing sidewalk or driveway, furnishing and placing concrete, constructing and sealing joints, and furnishing and installing truncated domes.

Payment will be made under:

Pay Item	**Pay Unit**
__ " Concrete Sidewalk	Square Yard
__ "Concrete Driveways	Square Yard
Concrete Wheelchair Ramps	Each

SECTION 850
CONCRETE PAVED DITCH

850-1 DESCRIPTION

Construct portland cement concrete paved ditches in accordance with the requirements shown on the plans for the various types of ditches and the requirements of these Specifications. Work includes but is not limited to all excavating and backfilling, furnishing and placing concrete, constructing curtain walls, and constructing and sealing joints.

850-2 MATERIALS

Refer to Division 10

Item	Section
Portland Cement Concrete, Class B	1000
Curing Agents	1026
Joint Fillers	1028-1
Joint Sealers	1028-2, 1028-4

850-3 CONSTRUCTION METHODS

Construct concrete in accordance with Section 825 and give a sidewalk finish, except as otherwise provided herein.

Broom the concrete surface transverse to the longitudinal centerline of the paved ditch. Make joint spacing no less than 5 feet.

Do not place backfill adjacent to the paved ditch until at least 3 curing days have elapsed unless otherwise approved. Compact backfill to a degree comparable to the adjacent undisturbed material.

850-4 MEASUREMENT AND PAYMENT

__" *Concrete Paved Ditch* will be measured and paid for in square yards that is completed and accepted. Longitudinal measurements will be made along the surface of the pavement at the centerline of the ditch and transverse measurements will be made along the surface of the pavement at right angles to the centerline. No measurement will be made of curtain walls at the beginning or ends of the paved ditches.

Payment will be made under:

Pay Item	Pay Unit
__ " Concrete Paved Ditch	Square Yard

SECTION 852
TRAFFIC ISLANDS AND MEDIANS

852-1 DESCRIPTION

Construct traffic islands and medians of the type required by the plans. Perform the work in accordance with the requirements of the contract.

852-2 MATERIALS

Refer to Division 10

Item	Section
Portland Cement Concrete, Class B	1000
Curing Aagents	1026
Joint Fillers	1028-1
Joint Sealers	1028-2, 1028-4
Herbicide	1060-13

852-3 CONSTRUCTION REQUIREMENTS

Construct curb, and curb and gutter, in accordance with the requirements of Section 846.

Uniformly grade and compact the earth or base course under any island or median to the same requirements as the surrounding material.

Treat aggregate and soil type base courses, and subgrade beneath other types of bases or directly beneath any concrete with a herbicide in accordance with Article 1670-7.

Construct concrete in accordance with Section 825 and give a sidewalk finish, except as otherwise provided herein. Broom concrete surfaces in medians transverse to the direction of traffic unless otherwise directed. Locate joints in island and median covers so as to line up with the joints in the curb and curb and gutter wherever possible. Locate joints in monolithic concrete islands and medians constructed adjacent to concrete pavement so as to line up with the joints in the concrete pavement wherever possible. Seal all joints.

Form openings in the island or island cover to accommodate sign posts.

852-4 MEASUREMENT AND PAYMENT

__ *" Concrete Island Cover* will be measured and paid for in square yards of concrete island cover that has been placed and accepted. Measurement will be made along the top surface of the completed island cover. This work includes but is not limited to excavation and backfilling, constructing base, furnishing and placing concrete, forming holes for signposts, and constructing and sealing joints.

__ *" Monolithic Concrete Islands ( )* will be measured and paid for in square yards of concrete island that has been placed and accepted. Measurement will be made parallel to the bottom surface of the island or median. This work includes but is not limited to excavation and backfilling, constructing base, furnishing and placing concrete, forming holes for signposts, and constructing and sealing joints.

__ *" Monolithic Concrete Median ( )* will be measured and paid for in square yards of concrete median that has been placed and accepted. Measurement will be made parallel to the bottom surface of the island or median. This work includes but is not limited to excavation and backfilling, constructing base, furnishing and placing concrete, forming holes for signposts, and constructing and sealing joints.

Payment for constructing earth fill will be made in accordance with Article 225-7 for *Unclassified Excavation* or Article 230-5 for *Borrow Excavation*, depending on the source of the material.

Payment for establishing a grass cover in unpaved island areas will be in accordance with Article 1660-8.

Payment for constructing *Concrete Curb* and *Concrete Curb and Gutter* will be made in accordance with Article 846-4.

Payment will be made under:

Pay Item	Pay Unit
__ " Concrete Island Cover	Square Yard
__ " Monolithic Concrete Islands ( )	Square Yard
__" Monolithic Concrete Median ( )	Square Yard

SECTION 854
CONCRETE BARRIER

854-1 DESCRIPTION

Construct portland cement concrete barrier in accordance with the requirements shown in the contract. The concrete barrier may be cast in place, slip formed, or precast, unless otherwise specified in the contract.

854-2 MATERIALS

Refer of Division 10

Item	Section
Portland Cement Concrete, Class AA	1000
Curing Agents	1026
Joint Fillers	1028-1
Joint Sealers	1028-4
Grout	1054-6
Reinforcing Steel	1070-2
Connector Pins and Eye Assemblies	1072
Guardrail and Barrier Delineators	1088-2

Use clear curing compound.

Galvanize connector pins and eye assemblies in accordance with Section 1076.

854-3 CONSTRUCTION METHODS

(A) Cast in Place or Slip Formed

Construct concrete in accordance with Section 825 and give an ordinary surface finish, except as otherwise provided herein.

Construct joints in accordance with the details shown on the plans. Seal expansion joints.

(B) Precast

Construct concrete in accordance with Section 825 and give an ordinary surface finish, except as otherwise provided herein. Use Class AA concrete.

Do not handle or remove the forms from barrier until the strength of the concrete reaches at least 2000 psi as evidenced by nondestructive tests made in place by a rebound hammer in accordance with ASTM C805.

Construct the base beneath the precast units so as to be equivalent to the adjacent pavement structure.

Lift and place precast units using a two-point pick up, or other approved method that will not overstress or damage the concrete. Do not use connectors for lifting purposes. Do not use lifting devices or methods that will mar the surface of the concrete. Do not use any precast unit that has been cracked, damaged, chipped, scarred, or otherwise disfigured.

(C) Barrier Delineators

Use any of the several alternate delineator types for barrier shown in the plans, but only one delineator type for barrier at any one time throughout the project.

The delineators consist of a reflector and base or casing. Attach the delineator to the barrier as shown in the plans. Only one attachment position will be permitted throughout the project length.

Position delineators perpendicular to the centerline of the road. Use yellow delineators in the median and on the left side of one-way ramps, loops, or other one-way facilities. Use crystal delineators on the right side of divided highways, ramps, loops and all other one-way or two-way facilities. In all cases, the color of the delineator shall supplement the color of the adjacent edgelines.

854-4 MEASUREMENT AND PAYMENT

Concrete Barrier, Type _____ will be measured and paid for in linear feet of barrier that has been completed and accepted. Measurement will be made along the top surface at the centerline of the barrier completed and in place with no deduction made for joints.

Variable Height Concrete Barrier, Type _____ will be measured and paid for in linear feet of barrier that has been completed and accepted. Measurement will be made along the top surface at the centerline of the barrier completed and in place with no deduction made for joints.

Concrete Barrier Transition Section will be measured and paid for in units of each for transitions completed and accepted.

There will be no measurement made of barrier delineators as they are considered incidental to the other pay items in this specification.

No direct payment will be made for the work of constructing any footing beneath the concrete barrier or concrete barrier transition sections as payment at the various contract unit prices for concrete barrier or concrete barrier transition sections will be full compensation for all such work.

Price and payment includes but is not limited to excavating, furnishing and placing concrete, reinforcing steel, grout, and hardware; transporting and placing precast units; galvanizing; constructing and sealing joints; and furnishing and installing barrier delineators.

Payment will be made under:

Pay Item	Pay Unit
Concrete Barrier, Type _____	Linear Foot
Variable Height Concrete Barrier, Type _____	Linear Foot
Concrete Barrier Transition Section	Each

SECTION 857
PRECAST REINFORCED CONCRETE BARRIER - SINGLE FACED

857-1 DESCRIPTION

Construct precast reinforced portland cement concrete barrier in accordance with the requirements shown in the contract.

857-2 MATERIALS

Refer to Division 10

Item	Section
Portland Cement Concrete, Class AA	1000
Curing Agents	1026
Joint Filler	1028-1
Grout	1054-6
Reinforcing Steel	1070-2
Eye Assemblies	1072
Guardrail and Barrier Delineators	1088-2

Use clear curing compound.

Galvanize eye assemblies in accordance with Section 1076.

857-3 CONSTRUCTION METHODS

Construct concrete in accordance with Section 825 and give an ordinary surface finish, except as otherwise provided herein.

Lift and place precast units using a two-point pick up or other approved method that will not overstress or damage the concrete. Do not use lifting devices or methods that will mar the surface of the concrete. Do not set any precast unit that is cracked, damaged, chipped, scarred, or otherwise disfigured.

Do not start installation of the precast concrete barrier until all components are prepared for a complete continuous installation, including the guardrail and guardrail anchors approaching the barrier. Once work has begun on a barrier installation, continue the work to

its completion unless weather or other conditions beyond the control of the Contractor interfere with the work.

Use any of the several alternate delineator types for barrier shown in the plans, but only one delineator type for barrier at any one time throughout the project.

The delineators consist of a reflector and base or casing. Attach the delineator to the barrier as shown in the plans. Only one attachment position will be permitted throughout the project length.

Position delineators perpendicular to the centerline of the road. Use yellow delineators in the median and on the left side of one-way ramps, loops, or other one-way facilities. Use crystal delineators on the right side of divided highways, ramps, loops and all other one-way or two-way facilities. In all cases, the color of the delineator shall supplement the color of the adjacent edgelines.

857-4 MEASUREMENT AND PAYMENT

There will be no measurement made of barrier delineators as they are considered incidental to the other pay items in this specification. *Precast Reinforced Concrete Barrier, Single Faced* will be measured and paid for in linear feet of barrier that has been completed, placed on the road, and accepted. Measurement will be made along the top surface at the centerline of the barrier with no deduction made for joints. Price includes but is not limited to furnishing and placing concrete and reinforcing steel, transporting, and placing precast units, grout, joint filler, hardware, galvanizing, constructing joints, and furnishing and installing barrier delineators.

Concrete Barrier Transition Section will be paid for in accordance with Section 854.

Payment will be made under:

Pay Item	Pay Unit
Precast Reinforced Concrete Barrier, Single Faced	Linear Foot

SECTION 858
ADJUSTMENT OF CATCH BASINS, MANHOLES, DROP INLETS, METER BOXES, AND VALVE BOXES

858-1 DESCRIPTION

Raise or lower existing catch basins, manholes, drop inlets, meter boxes, and valve boxes encountered within the limits of the project to match the adjacent finished work.

858-2 MATERIALS

Refer to Division 10

Item	Section
Portland Cement Concrete, Class B	1000
Curing Agents	1026
Asphalt Plant Mix	1020
Joint Fillers	1028-1
Joint Sealers	1028
Brick	1040-1
Concrete Block	1040-2
Mortar	1040-8
Reinforcing Steel	1070
Steps	1070
Fabricated Steel Grates	1074-9
Gray Iron Castings	1074-7
Precast Risers	1077

858-3 CONSTRUCTION REQUIREMENTS

Perform the adjustment with brick or block masonry or portland cement concrete on existing walls, in accordance with Subarticle 840-3(C).

Adjust manholes, meter boxes, and valve boxes as provided above or, where approved, by utilizing cast iron or steel fittings. When fittings are used, leave the existing walls in place and securely attach the fittings to the existing walls or install in a manner that will eliminate movement of the fitting.

Backfill excavated areas in an existing pavement with portland cement concrete. High early strength concrete may be used. Wait at least 72 hours after the placement of the concrete before placing any surfacing or resurfacing material over the concrete. This time period will not be required where the strength of the concrete is at least 2500 psi as evidenced by nondestructive tests made in place by a rebound hammer in accordance with ASTM C805. Thoroughly compact backfill of other excavated areas.

In areas open to traffic, construct a temporary ramp of asphalt plant mix around structures that have been adjusted. Construct the ramp to extend a minimum of 3 feet from the structure within one calendar day after completing the adjustment. Construct the ramp using any type of asphalt surface course plant mix meeting the requirements of any job mix formula issued by the Department for a Department project. Compact to an approved density.

Place bituminous plant mix flush with the top of the raised structure within 7 days after raising the structure.

Make the adjustments before the final layer of surfacing material is placed in areas to be surfaced or resurfaced. Salvage and reuse existing frames, grates, manhole covers, rings, and meter and valve boxes in the adjustment.

858-4 MEASUREMENT AND PAYMENT

Adjustment of Catch Basins will be measured and paid for in units of each for catch basins that have been satisfactorily adjusted.

Adjustment of Drop Inlets will be measured and paid for in units of each for drop inlets that have been satisfactorily adjusted.

Adjustment of Manholes will be measured and paid for in units of each for manholes that have been satisfactorily adjusted.

Adjustment of Meter Boxes or Valve Boxes will be measured and paid for in units of each for meter boxes or valve boxes that have been satisfactorily adjusted.

Where any one catch basin, drop inlet, manhole, meter box, or valve box is adjusted more than once because of milling operations, such adjustments will be counted as one adjustment.

Where a catch basin, manhole, drop inlet, meter box, or valve box is raised more than 2 feet , the number of linear feet exceeding 2 feet that such structure has been raised will be measured and paid for per linear foot as provided in Article 840-4 for *Masonry Drainage Structure*. Measurement will be made by subtracting the elevation at the highest point of the original structure from the elevation at the highest point of the adjusted structure, and then subtracting 2 feet from the results of the first subtraction.

Such price includes but is not limited to excavation and backfilling, removal of a portion of the existing structure, brick masonry, mortar, grout, concrete, reinforcing steel, fittings, furnishing and hauling asphalt plant mix and any other materials, and placing, maintaining, removing, and disposing of traffic ramps.

Payment will be made under:

Pay Item	Pay Unit
Adjustment of Catch Basins	Each
Adjustment of Drop Inlets	Each
Adjustment of Manholes	Each
Adjustment of Meter Boxes or Valve Boxes	Each

SECTION 859
CONVERTING EXISTING CATCH BASINS AND DROP INLETS

859-1 DESCRIPTION

Convert existing catch basins and drop inlets to either drop inlets or junction boxes, including all necessary construction and reconstruction in accordance with the requirements shown in the contract.

859-2 MATERIALS

Refer to Division 10

Item	Section
Portland Cement Concrete, Class B	1000
Curing Agents	1026
Joint Fillers	1028-1
Joint Sealers	1028-4
Brick	1040-1
Concrete Block	1040-2
Mortar	1040-8
Reinforcing Steel	1070
Structural Steel	1072
Steps	1074-8
Fabricated Steel Grates	1074-9
Gray Iron Castings	1074-7
Stone, No. 78M	1005

859-3 CONSTRUCTION METHODS

Perform work in accordance with the applicable requirements of Article 840-3 and the details shown in the plans. Raise or lower the existing catch basins and drop inlets as required by the plans and provisions.

859-4 MEASUREMENT AND PAYMENT

Convert Existing Catch Basin to Junction Box will be measured and paid for in units of each drainage structure that has been acceptably converted.

Convert Existing Catch Basin to Drop Inlet will be measured and paid for in units of each drainage structure that has been acceptably converted.

Convert Existing Drop Inlet to Junction Box will be measured and paid for in units of each drainage structure that has been acceptably converted.

Where a catch basin or drop inlet is raised more than 2 feet, the number of linear feet exceeding 2 feet that the catch basin or drop inlet has been raised will be measured and paid for per linear foot for Masonry Drainage Structure as provided for in Article 840-4. Measurement will be made by subtracting the elevation at the highest point of the original catch basin or drop inlet from the elevation at the highest point of the converted junction box or drop inlet, and then subtracting 2 feet from the results of the first subtraction.

If grates and frames are necessary in converting either catch basins or drop inlets, separate payment will be made for the grates and frames in accordance with Section 840.

Such price will include but is not limited to excavating hauling; removal of a portion of the existing structures, disposal of materials, furnishing, transporting, and placing backfill material, subsurface drainage, concrete, brick masonry, mortar, grout, reinforcing steel, hardware, casting, and miscellaneous metal, fabricating, welding, and galvanizing.

Payment will be made under:

Pay Item	Pay Unit
Convert Existing Catch Basin to Junction Box	Each
Convert Existing Catch Basin to Drop Inlet	Each
Convert Existing Drop Inlet to Junction Box	Each

SECTION 862
GUARDRAIL

862-1 DESCRIPTION

Construct either permanent or temporary steel beam guardrail, in accordance with the requirements of the contract and at the locations designated on the plans or as directed.

862-2 MATERIALS

Refer to Division 10

Item	Section
Rail Elements	1046-2
Posts and Offset blocks	1046-3
Hardware	1046-4
Anchors	1046-5
Welded Wire Fabric	1070-3
Organic Zinc Repair Paint	1080-9
Guardrail and Barrier Delineators	1088-2
Guardrail End Delineation	1088-3
Select Material, Class VI	1016

Supply material in accordance with the Department's Brand Certification Program for Guardrail.

Temporary guardrail shall be of the type called for on the plans and shall be fabricated from plates that are not less than 12 gauge in thickness. Used materials are acceptable for temporary guardrail construction provided their condition is approved.

862-3 CONSTRUCTION METHODS

Erect the rail elements to produce a smooth continuous rail paralleling the line and grade of the highway surface or as shown on the plans. Lap the rail elements in the direction of traffic. Re-lap the rail elements if required by traffic phasing. Field drill holes for special details. Field punching holes is allowed. Attach terminal sections, when required, to the ends of each installation and lap on the face of the rail.

Install shop curve guardrail in accordance with the plans.

Posts may be power driven, or set by hand. Protect the top of steel posts by a suitable driving cap if power driven. If set by hand, dig post holes to the depth and at the locations

shown on the plans. Thoroughly ram the bottom of the post holes so that the posts will have a stable foundation. Set the posts plumb and accurately space and line. Backfill the post holes in 6" layers with suitable material and thoroughly compact by tamping or puddling.

Where rock interferes with the proper installation of the post, excavate a shaft in the rock not less than 9" wide, parallel to the roadway, by 23" long, perpendicular to the roadway, and 24" deep. Place the post against the roadside edge of the shaft and fill in behind the post with Select Material Class VI, up to the top elevation of the rock. Fill the remainder of the hole with earth material. Where timber posts are to be driven in fill slopes 1 1/2:1 or steeper and the fill height is 15 feet or more, auger a 6" diameter pilot hole to the full depth of the post before driving.

Where steel posts are required to be installed at box culverts, weld the post to the anchor plate, cut off, and align in accordance with the details shown in the plans or as directed.

Use the same type of guardrail posts and offset blocks throughout the project unless otherwise directed or detailed in the plans.

After galvanized guardrail has been erected, clean all scarred, scratched, or abraded areas of all loose spelter coat and rust. Paint with organic zinc repair paint 3 mils thick.

When guardrail is being constructed near traffic, conduct operations so as to constitute the least hazard to the public. Schedule and conduct operations to construct and complete each individual continuous guardrail installation in the least possible time.

Do not begin work on any section of new guardrail until preparations are made to fully complete the installation of the section as a continuous operation. Once work is initiated on a section, pursue the work to its completion unless inclement weather or other conditions beyond the control of the Contractor interfere with the work. Begin attachment of the rail elements at the approach end of the guardrail and continue in the same direction as the movement of traffic.

When directed, install guardrail posts and blocks at locations that are in addition to those required by the plans.

Install tubular triple corrugated steel beam guardrail on concrete bridges or driven posts or at locations shown in the plans in accordance with the details shown in the plans and as directed. Where the tubular triple corrugated steel beam guardrail is to be mounted on concrete, use steel posts, weld the post to the anchor plate, cut off, and align in accordance with the details shown in the plans or as directed.

862-4 GUARDRAIL DELINEATORS

Use any of the several alternate delineator types for guardrail shown in the plans, but only one delineator type for guardrail at any one time throughout the project.

The delineators consist of a reflector and base or casing. Attach the delineator to the guardrail as shown in the plans. Only one attachment position will be permitted throughout the project length.

Position delineators perpendicular to the centerline of the road. Use yellow delineators in the median and on the left side of one-way ramps, loops, or other one-way facilities. Use crystal delineators on the right side of divided highways, ramps, loops and all other one-way

or two-way facilities. In all cases, the color of the delineator shall supplement the color of the adjacent edgelines.

862-5 TEMPORARY GUARDRAIL

Erect temporary guardrail in accordance with the requirements of Section 1046 and the contract.

Temporary guardrail may be reused if it is still in satisfactory condition.

After temporary guardrail is no longer needed, it becomes the property of the Contractor. Remove the temporary guardrail from the project.

862-6 MEASUREMENT AND PAYMENT

Steel Beam Guardrail will be measured and paid for in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of the outermost post in the length of guardrail being measured.

Steel Beam Guardrail, Shop Curved will be measured and paid for in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of the outermost post in the length of guardrail being measured.

Steel Beam Guardrail, Double Faced will be measured and paid for in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of the outermost post in the length of guardrail being measured.

Triple Corrugated Steel Beam Guardrail will be measured and paid for in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of the outermost post in the length of guardrail being measured.

20″ Tubular Triple Corrugated Steel Beam Guardrail will be measured and paid for in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of the outermost post in the length of guardrail being measured.

Temporary Steel Beam, Guardrail will be measured and paid for in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of the outermost post in the length of guardrail being measured.

Temporary Steel Beam Guardrail, Shop Curved will be measured and paid for in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of the outermost post in the length of guardrail being measured.

Temporary Steel Beam Guardrail, Double Faced will be measured and paid for in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of the outermost post in the length of guardrail being measured.

Steel Beam Guardrail Terminal Section and Temporary Steel Beam Guardrail Terminal Sections will be measured and paid for in units of each that have been completed and accepted, exclusive of terminal sections that are within the pay limits of guardrail anchors.

Triple Corrugated Steel Beam Guardrail Terminal Sections will be measured and paid for in units of each that have been completed and accepted, exclusive of terminal sections that are within the pay limits of guardrail anchors.

Guardrail Anchor Units, Type __ and *Temporary Guardrail Anchor Units Type __* will be measured and paid for as units of each that have been completed and accepted. No separate measurement will be made of any rail, terminal sections, posts, offset blocks, concrete, hardware, or any other components of the completed unit that are within the pay limits shown on the plans for the unit as all such components will be considered to be part of the unit.

W-TR Steel Beam Guardrail Transition Sections will be measured and paid for in units of each that have been completed and accepted.

Additional Guardrail Posts will be measured and paid for in units of each for additional posts required but not shown in the plans.

There will be no measurement or payment made for *Guardrail Delineators* as they are considered incidental to the other pay items in this Specification.

There will be no measurement or payment made for *Guardrail End Delineation* as it is considered incidental to the other pay items in this Specification.

Such price and payment includes, but is not limited to furnishing and erecting posts, offset blocks, rail, terminal sections, miscellaneous hardware, and all other materials, field curving and shop curving of the rail; removing temporary guardrail; excavation; furnishing and installing additional guardrail posts and additional offset blocks; backfilling; fabrication; welding; galvanizing; furnishing and installing guardrail delineators and end delineation.

Payment will be made under:

Pay Item	Pay Unit
Steel Beam Guardrail	Linear Foot
Steel Beam Guardrail, Shop Curved	Linear Foot
Steel Beam Guardrail, Double Faced	Linear Foot
Triple Corrugated Steel Beam Guardrail	Linear Foot
20" Tubular Triple Corrugated Steel Beam Guardrail	Linear Foot
Temporary Steel Beam Guardrail	Linear Foot
Temporary Steel Beam Guardrail, Shop Curved	Linear Foot
Temporary Steel Beam Guardrail, Double Faced	Linear Foot
Temporary Guardrail Anchor Units, Type ___	Each
Temporary Steel Beam Guardrail Terminal Sections	Each
Steel Beam Guardrail Terminal Section	Each
Triple Corrugated Steel Beam Guardrail Terminal Sections	Each
Guardrail Anchor Units, Type ___	Each
W-TR Steel Beam Guardrail Transitions Sections	Each
Additional Guardrail Posts	Each

SECTION 863
REMOVE EXISTING GUARDRAIL

863-1 GENERAL

Dismantle, remove and dispose of existing guardrail and anchors of any type at locations shown on the plans or established by the Engineer and in accordance with this specification.

863-2 CONSTRUCTION METHODS

Remove guardrail and posts beginning at the trailing end and continuing towards the approach end. Remove the posts immediately after the rail is removed. Complete post removal so that no posts without rail attached are present at the end of any day's operations. Exercise care not to damage adjoining structures or other appurtenances. Repair all damage at no cost to the Department. All guardrail and components removed are the property of the Contractor.

863-3 MEASUREMENT AND PAYMENT

Remove Existing Guardrail will be measured and paid for in linear feet of guardrail that has been satisfactorily removed. Measurement will be made to the nearest 1.0 foot from center to center of the outermost post or end shoe center bolt in the length of the guardrail being removed. Measurement will be made prior to removing the guardrail.

Payment will be made under

Pay Item	Pay Unit
Remove Existing Guardrail	Linear Foot

SECTION 864
REMOVE AND RESET EXISTING GUARDRAIL AND GUIDERAIL

864-1 GENERAL

Remove and reset existing guardrail and guiderail and anchors of any type at locations shown in the plans and as directed in accordance with the contract.

864-2 CONSTRUCTION METHODS

Exercise care not to damage adjoining structures or other appurtenances. Repair all damage at no cost to the Department. Reset existing guardrail and guiderail in accordance with Article 862-3 and 865-3. Reset guardrail and guiderail in a condition that is equal to or better than the condition that exists before the guardrail and guiderail is removed. Replace any of the guardrail and guiderail components that have been unnecessarily damaged.

864-3 MEASUREMENT AND PAYMENT

Remove and Reset Existing Guardrail will be measured and paid for in linear feet of guardrail and anchors that has been removed, reset, and accepted. Measurement will be made after the guardrail has been reset.

Remove and Reset Existing Guiderail will be measured and paid for in linear feet of guiderail and anchors that has been removed, reset, and accepted. Measurement will be made after the guiderail has been reset.

Such price will include but is not limited to removing and resetting the guardrail, guiderail, and anchors and for furnishing all equipment, labor, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
Remove and Reset Existing Guardrail	Linear Foot
Remove and Reset Existing Guiderail	Linear Foot

SECTION 865
CABLE GUIDERAIL

865-1 DESCRIPTION

Construct cable guiderail in accordance with the contract and at the locations designated in the plans or as directed.

865-2 MATERIALS

Refer to Division 10:

Item	Section
Rail Elements	1046-2
Posts	1046-3
Hardware	1046-4
Organic Zinc Repair Paint	1080-9
Portland Cement Concrete, Class A	1000
Precast Concrete Anchors	1077
Select Material, Class VI	1016

Manufacture cable in accordance with AASHTO M-30, Type I, Class A. The cable shall be pre-inspected at the producer's facility prior to shipment.

865-3 CONSTRUCTION METHODS

Erect the rail elements to produce a smooth continuous rail paralleling the line and grade of the highway surface or as shown on the plans.

Posts may be power driven, or set by hand. Protect the top of steel posts by a suitable driving cap if power driven. If set by hand, dig post holes to the depth and at the locations shown on the plans. Thoroughly ram the bottom of the post holes so that the posts will have a stable foundation. Set the posts plumb and accurately space and align. Backfill the post holes in 6" layers with suitable material and thoroughly compact by tamping or puddling.

Where rock interferes with the proper installation of the post, excavate a shaft in the rock not less than 9" wide, parallel to the roadway, by 23" long, perpendicular to the roadway, and 24" deep. Place the post against the roadside edge of the shaft and fill in behind the post with Select Material Class VI, up to the top elevation of the rock. Fill the remainder of the hole with earth material. Where timber posts are to be driven in fill slopes 1 1/2:1 or steeper and the fill height is 15 feet or more, auger a 6" diameter pilot hole to the full depth of the post before driving.

Where steel posts are required to be installed at box culverts, weld the post to the anchor plate, cut off, and align in accordance with the details shown in the plans or as directed.

When guiderail is being constructed near traffic, conduct operations so as to constitute the least hazard to the public. Schedule and conduct operations to construct and complete each individual continuous guiderail installation in the least possible time.

Do not begin work on any section of new guiderail until preparations are made to fully complete the installation of the section as a continuous operation. Once work is initiated on a section, pursue the work to its completion unless inclement weather or other conditions beyond the control of the Contractor interfere with the work. Begin attachment of the cable elements at the approach end of the guiderail and continue in the same direction as the movement of traffic.

865-4 MEASUREMENT AND PAYMENT

Cable Guiderail will be measured and paid for in linear feet of guiderail that has been satisfactorily completed and accepted exclusive of that length of guiderail that is within the pay limits of guiderail anchors. Measurement will be made from center to center of the outermost post in the length of guiderail being measured. Such price will include but is not limited to furnishing and erecting posts, cable, miscellaneous hardware, concrete, delineators, and all incidentals necessary to complete the work.

Double Faced Cable Guiderail will be measured and paid for in linear feet of guiderail that has been satisfactorily completed and accepted exclusive of that length of guiderail that is within the pay limits of guiderail anchors. Measurement will be made from center to center of the outermost post in the length of guiderail. Such price will include but is not limited to furnishing and erecting posts, cable, miscellaneous hardware, concrete, delineators, and all incidentals necessary to complete the work.

Cable Guiderail Anchor Unit will be measured and paid for in units of each that have been completed and accepted.

No separate measurement will be made of any cable, posts, concrete, hardware, or any other components of the completed anchor units that are within the pay limits shown on the plans.

Payment will be made under:

Pay Item	Pay Unit
Cable Guiderail	Linear Foot
Double Faced Cable Guiderail	Linear Foot
Cable Guiderail Anchor Unit	Each

SECTION 866
FENCE

866-1 DESCRIPTION

Furnish and erect woven wire, chain link, and barbed wire fence with gates in conformity with the details shown on the plans and at locations as shown on the plans.

866-2 MATERIALS

Refer to Division 10

Item	Section
Portland Cement Concrete, Class B	1000
Timber Posts and Braces	1050-2
Metal Posts and Rails	1050-3
Barbed Wire	1050-4
Woven Wire	1050-5
Chain Link Fabric	1050-6
Fittings and Accessories	1050-7
Fence Materials	1050-1

Use Class B concrete for anchors. In lieu of Class B concrete, pre-mixed commercially bagged dry concrete mix provided the concrete meets the minimum strength requirements for Class B concrete when mixed with the quantity of water shown on the instructions printed on the bag may be used.

866-3 CONSTRUCTION METHODS

(A) Clearing and Grubbing

Only clear the ground that is absolutely necessary to erect a clear fence line. Clearing includes satisfactory removal and disposal of all trees, brush, stumps, or other objectionable material. Erect the fence to conform to the general contour of the ground. Place the bottom of the fabric or wire no more than 6" above the natural ground, except where the Engineer directs that ditches and depressions are to be spanned by using extra length posts in conjunction with additional barbed wire installed between the bottom of the fence wire or fabric and the ground surface. Grade along the fence line to meet the above requirement such that no obstructions to proper drainage are created.

(B) Setting Posts and Braces

Set and maintain all posts in a vertical position. Line posts may be hand set or set with a post driver. Thoroughly tamp all backfilled material if hand set. If power driven, wood posts may be sharpened to a dull point. Remove and replace posts that are damaged by power driving.

Set posts in concrete anchors to maintain the position and alignment of the post when required on the plans or where dictated by soil conditions. Forms are not required for the concrete. Trowel the top of the concrete to a smooth finish and slope to drain away from the post. The concrete anchors require at least a 3 day curing period before any load is placed on the post.

In lieu of setting roll formed steel line posts in concrete, such posts may be driven provided they are not part of a line brace assembly. Drive the posts a minimum of 3 feet into the ground. Provide adequate protection to the post tops to prevent damage from the driving operations. Repair damage to the zinc coating of otherwise acceptable driven posts by brushing with a steel wire brush to remove flaked and cracked zinc coating and by painting with enough coats to equal 3 mils thick of organic zinc repair paint meeting the requirements of Article 1080-9. Set posts in concrete anchors where soil conditions are such that the posts cannot be driven without deformation, or where soils are encountered that does not provide adequate in-ground stability.

Where rock or concrete pavement or slabs are encountered within the required depth where fence posts are to be erected, drill a hole in the rock or concrete of a diameter slightly larger than the largest dimension of the post in the rock or concrete and grout in the post. The depth of post embedment shown on the plans will not be required and the post may be shortened as necessary, provided the post is embedded within the rock or concrete pavement or slab to a minimum depth of 12".

Do not fabricate extra length posts by welding short sections of posts together.

Place line braces at the end of each roll or piece of woven wire.

Do not use pieces of woven wire fabric less than 100 feet in length, unless otherwise directed. When the use of short pieces of woven wire is permitted, furnish and install the additional required brace posts and braces at no cost to the Department. Approved splicing sleeves may be used in lieu of providing such brace posts and braces.

Set approved sleeves in retaining wall in accordance with the details in the plans. After the posts have been set, fill sleeves with grout.

(C) Installing Fabric and Wire

(1) Chain Link Fence

Attach chain link fabric to tubular end, gate, corner, or brace posts with stretcher bars and stretcher bar bands as shown on the plan. Fasten the fabric to line posts and to top and brace rails with wire fasteners spaced and wound as shown on the plans. Fasten the fabric to the tension wire by hog rings spaced at 24" intervals, or weave the tension wire through the fabric. Make hog ring ties at fabric joints with the hog ring passing completely around the fabric joint.

Place chain link fabric by securing or fastening on end and applying sufficient tension to remove all slack before making permanent attachments elsewhere. Apply the tension for stretching by mechanical fence stretchers designed for this purpose.

Connect rolls and pieces of chain link fabric to each other by field weaving provided that such weaving is identical in appearance and strength as the machine weaving done at the factory.

Attach barbed wire used in conjunction with chain link fabric, to the post by means of eyebolt or by a tie wire passing through holes drilled in the metal post so as to prevent any vertical movement of the barbed wire. Wrap the ends and beginnings of strands around the post twice and securely fasten by winding the end around the wire near the post. Splice barbed wire only at posts.

Install additional barbed wire when shown on the plans or where directed.

(2) Woven Wire Fence

Stretch woven wire fabric taut and securely attach to each post with a staple in each line of wire. Use as many additional staples as required to firmly secure the wire at the location and elevation required by the plans. When woven wire is attached to metal posts, use at least 5 clips at each post to fasten the individual strands of wire to the post except where wrapping of the strand around the post is required. Stretch with an approved stretcher that will produce equal tension in each line of wire.

At each end or gate post, at the center post in each line brace and at corner posts except as otherwise shown on the plans, cut out all vertical strands of wire and wrap each horizontal strand of wire around the post and securely fasten by winding the end around the strand of wire near the post.

Do not splice fabric between the posts of a brace post assembly. Do not splice between other posts, unless the splicing sleeves are approved.

Pull woven wire taut and securely attach to each post by methods described for woven wire when used in conjunction with woven wire fabric. Do not splice woven wire between posts.

Install additional woven wire as shown on the plans or where directed.

(3) Barbed Wire Fence

Install barbed wire fence in accordance with the plans and as directed.

Pull barbed wire taut and securely attach to each post by methods described for woven wire. Do not splice barbed wire between posts.

866-4 MEASUREMENT AND PAYMENT

Woven Wire Fence, __ " Fabric will be measured and paid for in linear feet of fence, measured in place from center of each post or gate post to center of end post or gate post exclusive of gate sections, that has been completed and accepted.

Chain Link Fence, __ " Fabric will be measured and paid for in linear feet, of fence measured in place from center of each post or gate post to center of end post or gate post exclusive of gate sections, that has been completed and accepted.

___ *Strand Barbed Wire Fence with Posts* will be measured and paid for in linear feet of fence measured in place from center of each post or gate post to center of end post or gate post exclusive of gate sections, that has been completed and accepted. All posts used for the barbed wire fence are included in the price of the barbed wire fence and will not be paid for separately.

__ " *Timber Fence Posts,* ____ will be measured and paid for in units of each for the several sizes and kinds of posts installed on the project, including timber posts erected as barriers at driveways and entrances. The actual length of timber posts in linear feet of variable length and extra length posts shall be measured as placed and converted to an equivalent number of standard length posts of the same size for which a pay item has been established. In converting to equivalent numbers of standard length posts, any fractional portion of a post remaining from the division of a total number of linear feet by a standard post length shall be considered as equal to one post. Where the Contractor has elected to use pieces of woven wire shorter than 100 feet in length, as permitted by Subarticle 866-3(B), on the condition that he furnish and install at no additional cost to the Department line braces at the ends of short pieces, timber fence posts shall also include the number of line posts that have been made unnecessary by such line braces but shall exclude the posts used in the line braces.

Metal Line Posts for __ " Chain Link Fence will be measured and paid for in units of each for the several sizes and kinds of posts actually installed on the project. For extra length metal posts, the actual length of post in place in excess of the standard pay length for each post shall be measured in linear feet, and one half of such length shall be converted to an equivalent number of standard length posts of the same size for which a pay item has been established. In converting to equivalent numbers of standard length posts, any fractional portion of a post remaining from the division of a total number of linear feet by a standard post length shall be considered as equal to one post.

Metal Terminal Posts for __ " Chain Link Fence will be measured and paid for in units of each for all end, corner, and brace posts installed on the project.

Metal Gate Posts for __ " Chain Link Fence, Double Gate will be measured and paid for in units of each for gateposts installed on the project.

Metal Gate Posts for __ " Chain Link Fence, Single Gate will be measured and paid for in units of each for gate posts installed n the project.

Double Gates, ___High, ___Wide, ____ Opening will be measured and paid for in units of each for the number of gates actually erected on the project. Double gates will be measured as one gate.

Single Gates, __ High, __Wide, __ Opening will be measured and paid for in units of each for the number of gates actually erected on the project.

Additional Barbed Wire will be measured and paid for in linear feet of wire installed in the work, complete and in place. Measurement of additional barbed wire will be made along each strand after the installation has been completed. No measurement will be made of any wraps, nor will measurement be made of the upper or lower continuous strand of barbed wire that is erected as part of woven wire fence.

Setting sleeves in retaining wall will not be paid for as such work is considered incidental to the other pay items in this specification.

Work includes but is not limited to clearing and grading; and furnishing and installing fence fabric, barbed wire, staples, tie wires, stretcher bars, top rails, tension wire, posts and post braces, concrete, gates, fittings, and any other materials, furnishing and installing sleeves in retaining walls and filling sleeves upon setting posts.

(A) Pay Items

Payment will be made under:

Pay Item	Pay Unit
Woven Wire Fence, ___" Fabric	Linear Foot
Chain Link Fence, ___" Fabric	Linear Foot
___ Strand Barbed Wire Fence with Posts	Linear Foot
___" Timber Fence Posts, ___' Long	Each
Metal Line Posts for ___" Chain Link Fence	Each
Metal Terminal Posts for ___" Chain Link Fence	Each
Metal Gate Posts for ___" Chain Link Fence, Double Gate	Each
Metal Gate Posts for ___" Chain Link Fence, Single Gate	Each
Double Gates, ___ High, ___ Wide, ___ Opening	Each
Single Gates, ___ High, ___ Wide, ___ Opening	Each
Additional Barbed Wire	Linear Foot

SECTION 867
FENCE RESET

867-1 DESCRIPTION

Remove and reset existing fences of various types to the locations indicated in the plans or where directed.

867-2 CONSTRUCTION METHODS

Reset the fence in a condition that is equal to or better than before the fence is removed. Replace any of the fence components unnecessarily damaged by the Contractor's forces.

The Contractor will be responsible for damage caused by livestock escaping or entering the existing fenced area through the negligence of his forces.

If the owner of the fence desires to repair, rebuild, or renew any parts of the fence, and agrees to furnish the materials without cost to the Contractor, then repair, rebuild, renew, and reset such fence using the material furnished by the owner at no additional cost to the owner or the Department.

867-3 MEASUREMENT AND PAYMENT

_____ *Fence Reset* will be measured and paid for in the linear feet of fence that has been acceptably reset. Measurement will be made along the fence after it has been reset from center of end post to center of end post. Such price includes but is not limited to removing, hauling, and re-erecting the existing fence; and furnishing and installing any fence components unnecessarily damaged by the Contractor's forces.

Payment will be made under

Pay Item	Pay Unit
_____Fence Reset	Linear Foot

SECTION 869
RELAPPING GUARDRAIL

869-1 DESCRIPTION

Relap either existing or recently installed guardrail in accordance with the requirements of the contract and where directed.

869-2 CONSTRUCTION METHODS

Where required by the traffic phasing, at locations shown on the plans, or where directed, relap guardrail to conform to the required traffic pattern. Complete all required relapping of guardrail and have it inspected prior to shifting traffic into a new traffic pattern. All guardrail shall be lapped in the direction of traffic prior to placing traffic next to the guardrail.

869-3 MEASUREMENT AND PAYMENT

Relapping Guardrail will be measured and paid for in linear feet of guardrail that has been satisfactorily relapped and accepted. Measurement will be made from center to center of the outermost post in the length of guardrail being measured. Such price includes but is not limited to providing all necessary labor, tools, equipment, and materials necessary to acceptably relap the guardrail.

Payment will be made under:

Pay Item	Pay Unit
Relapping Guardrail	Linear Foot

SECTION 876
RIPRAP

876-1 DESCRIPTION

Place riprap at the locations designated in the contract and as directed.

876-2 MATERIALS

Refer to Division 10

Item	Section
Plain Riprap	1042
Filter Fabric for Drainage, Type 2	1056

Plain riprap consists of quarry run stone, or field stone, or broken concrete, and is classified by size into either Class 1 or Class 2. Plain riprap when classified as either Class A or Class B shall consist of quarry run stone or field stone. Use the class and thickness called for on the plans. Place filter fabric under plain riprap where indicated in the plans.

876-3 PLAIN RIPRAP

Place the stone where indicated in the plans, unless otherwise directed. Grade the stone so that the smaller stones are uniformly distributed throughout the mass.

Place the stone by mechanical methods, augmented by hand placing where necessary. Complete the riprap to form a properly graded, dense, neat layer of stone.

Install the riprap to at least the thickness indicated on the plans. At locations where riprap is required for channel changes and drainage ditches, place the riprap prior to diverting the water into the channel changes and drainage ditches.

At locations where riprap is required at the outlets of pipe culverts, place the riprap immediately after completion of the pipe culvert installation.

Unless otherwise directed, grade the surfaces that receive filter fabric to the lines and grades shown on the plans. Provide a surface free of obstructions, debris, and soft pockets.

Do not leave fabric uncovered for more than 7 days. Lay the fabric smooth and free from tension, stress, folds, wrinkles, or creases. Make horizontal overlaps a minimum of 12 inches with the upper fabric overlapping the lower fabric. Make vertical overlaps a minimum of 18 inches with the upstream fabric overlapping the downstream fabric. Place the riprap in a continuous manner. Protect the fabric from damage while placing riprap or other materials.

In the event that the fabric is displaced or damaged during riprap placement, remove the riprap and reposition or replace the fabric prior to replacement of the riprap, all at no additional cost to the Department.

876-4 MEASUREMENT AND PAYMENT

Riprap, Class__ will be measured and paid for in tons that has been incorporated into the completed and accepted work. The riprap will be measured by being weighed in trucks on certified platform scales or other certified weighing devices.

Filter Fabric for Drainage will be measured and paid for in square yards measured along the surface of the ground, over fabric that has been acceptably placed. No separate measurement will be made for overlapping fabric, sewing seams or bonding.

Such price will include, but is not limited to all excavation, embankment preparation, and backfilling; and stone or broken concrete riprap, filter fabric, and other materials.

Payment will be made under

Pay Item	**Pay Unit**
Riprap, Class_____	Ton
Filter Fabric for Drainage	Square Yard

DIVISION 9
SIGNING

SECTION 900
GENERAL REQUIREMENTS FOR SIGNING

900-1 DESCRIPTION

Furnish, fabricate and erect complete traffic sign and sign lighting systems in accordance with the requirements of the contract.

900-2 ACCEPTANCE OF SIGNS

Prior to final inspection of the signs, clean exposed sign and support surfaces, and repair the site as may be deemed necessary to ensure the safety, effectiveness and neat appearance of the work.

Maintain responsibility for the signs until accepted. Any damaged sign will not be accepted. Any repairs to the signs before final acceptance of the project are to be approved.

Do not perform any repair work without written approval. Make repairs only under the supervision of the Engineer.

Handle, transport, and store all signs in accordance with the sheeting manufacturer's recommendations. Failure to comply with the manufacturer's recommendations during the handling, transportation, and storage of the signs will be cause for rejection of the signs.

The Contractor may request early Department acceptance of part or all of the highway signs, including sign panels, retroreflective sheeting, and associated hardware, before final project acceptance. Sign supports will not be accepted early. To be accepted prior to final project acceptance, the signs shall be required for traffic control at that phase of project construction.

If the Department accepts the signs, the Contractor will be relieved of the responsibility for any damage and/or theft that may occur to the signs, retroreflective sheeting, or associated hardware, with exception of any damage caused by the Contractor or any subcontractor working on the project.

900-3 ALTERNATE DESIGN

Standard designs for Types A, B, D, E, and F ground mounted signs will be shown in the contract. In lieu of the standard design, the Contractor may submit for approval an alternate design for sign panels differing in component parts and construction details from those shown in the contract. Provide any alternate designs that are in accordance with the *Manual on Uniform Traffic Control Devices,* published by FHWA.

Submit complete details of the alternate sign designs to the Engineer for approval. Include the dimensions, thickness, and alloys of the component parts, and typical shop drawings of all fabrication, erection, and construction details.

Alternate design for supports and footings will not be permitted.

900-4 COVERING OF SIGNS

Cover signs or portions of signs that have been erected on roads to traffic, but that are not yet applicable to traffic. Keep signs or portions of signs covered until instructed to remove the covering. Provide covering for entire signs by method approved by sheeting manufacturer that will prevent the messages from being read or seen during both day and night conditions and that will cause no harm to the sheeting face.

SECTION 901
SIGN FABRICATION

901-1 DESCRIPTION

Fabricate and furnish signs, including sign face, supporting frames, hardware, and package the signs for shipment.

901-2 MATERIALS

Refer to Division 10:

Item	Section
Signs and Hardware	1092-1
Retroreflective Sheeting	1092-2

CONSTRUCTION METHODS

(A) General

Details concerning the fabrication and erection of the signs are shown in the contract. Sign designs not shown in the contract are available from the Signing Engineer.

All items shall be fabricated to within 1/8” of exact measurements.

Scribe each sign, shield, arrow, overlay and/or blank on the back with the month and year of manufacture and the metal treater of the aluminum sheets.

Do not begin fabrication for Type A & B signs until S dimensions verification revisions have been approved.

Provide mounting holes in the Z stringers of the signs in accordance with the details shown in the contract or approved shop drawings. Provide a space between the ‘Z’ bar and backing strip not greater than 1/8”.

Date the erection of all signs and sign assemblies using printed self-adhesive stickers designed for punching the appropriate day, month, and year numbers with a hole punch. Place the sticker on the back of each sign in the lower corner nearest the roadway. The Sign Fabricator will provide a sufficient quantity of the stickers for each sign. Print on the back of each sign the size of that sign [e.g. 144” X 48”] with a black permanent marker with numbers a minimum of 2 inches in height and located near the self-adhesive sticker.

(B) Department and Contractor Furnished Signs

The contract will show whether the signs are to be fabricated and furnished by the Contractor or whether the Department will provide them to the Contractor.

For both Department and Contractor Furnished Signs, the Contractor provides all mounting hardware consisting of, but not limited to, backing plates, mounting bolts, washers, shims, and nuts.

The sign fabricator will provide vertical Z bars required for attaching secondary signs to the primary signs.

Confirm in writing a minimum of 4 months in advance, the actual date the Department furnished signs will be required. The signs will be made available to the Contractor for pickup at the North Carolina Department of Correction sign fabrication facility on NC 39 near Bunn, North Carolina, unless otherwise indicated in the Specifications. Provide for all transportation.

The Engineer will inspect and approve the signs before they are packaged and crated for shipment. Any inspection by the Contractor will be done at no cost to the Department. Take delivery of all signs within 60 days of the date requested or the date they are made available, whichever occurs last, and within 96 hours of receiving the first sign. The Engineer shall approve any exception to the above delivery procedure. At the time the signs are delivered to the project, provide to the Engineer one copy of the sales ticket furnished with the signs. Signs stored beyond these dates incur a storage fee of 5% of the cost of the sign per month or portion thereof.

After taking possession of the signs, be responsible for any damage and/or theft that occurs to signs prior to final acceptance by the Engineer. Comply with the reflective sheeting manufacturer's recommendations for handling, transporting, erecting, and storage of the signs. Acceptably repair or otherwise correct any damage to the signs or refabricate them at no cost to the Department. When requested by the Contractor, the Department may have the necessary repairs made, or the signs refabricated, and deduct the associated costs thereof from monies due the Contractor.

(C) Signs

Construct all signs, supporting frames and assemblies in accordance with the details shown in the contract.

TABLE 901-1
SIGN TYPE PARAMETERS

SIGN TYPE	VERT. AND HORIZ. DIMENSIONS Inches	ALUMINUM PANELS (144" x 48")	HORIZANTAL Z BARS	ALUMIMUN THICKNESS Inches
A	1. Vertical or Horizontal > 144 or 2. Vertical and Horizontal > 48	Multiple	Yes	0.125
B	1. Vertical and Horizontal ≤ 144, and 2. Vertical or Horizontal ≤ 48	Single	Yes	0.125
D		Single	No	See Table 901-2
E		Single	No	See Table 901-2
F		Single	No	See Table 901-2

(1) Type A Signs

Fabricate Type A signs from multiple 0.125" aluminum sheet increments, with welded studs for attachment to the supporting frame. Type A signs may be fabricated from multiple 0.080" aluminum sheet increments, with the use of very high bond acrylic foam tape capable of obtaining 140 psi tensile adhesion, for attachment to the supporting frame.

Use aluminum sheets with increments of 4 feet in width; except, for sign widths that are not multiples of 4 feet, a maximum of two (2) panels may be cut to less than 4 feet. No panel may be cut to less than 1 foot. Mount aluminum sheet increments vertically, and provide with backing strips at the vertical joints, held firmly in place, to keep the abutting sheets in proper alignment. Leave a minimum space of .020" to a maximum space of .032" between each panel.

Fabricate signs with a height of 12 feet or less, without horizontal joints. One horizontal joint will be permitted for signs that are more than 12 feet in height. Locate the joint near the mid-height of the sign. Construct this joint according to the details as shown in the contract.

(2) Type B Signs

Fabricate Type B signs from single 0.125" aluminum sheets, with welded studs for attachment to the supporting frame. Type B signs may be fabricated from single 0.080" aluminum sheets, with the use of very high bond acrylic foam tape capable of obtaining 140 psi tensile adhesion, for attachment to the supporting frame

(3) Type D, E, F Signs and Milemarkers

Fabricate Types D, E, F signs and milemarkers from single sheets, with holes for bolting to the supports. Construct Type D, E, F signs and milemarkers of the thickness shown in Table 901-2.

Construct Type E and F signs in accordance with the FHWA Standard Highway Signs or the NC Supplement to the MUTCD. Apply the retroreflective sheeting to the separate signs in all Types E and F sign assemblies consecutively to provide correct color matching on each completed assembly. Adequately identify each individual sign to the correct assembly. Following the erection of Types E and F sign assemblies, leave the identification markings on the individual signs until Department personnel have verified compliance with these requirements.

(4) Overlays for Existing Signs

Manufacture all overlays for existing signs from 0.063" aluminum sheeting, unless otherwise required by the contract. Do not make holes for rivets in the overlays during fabrication, but instead field-drill them during the erection process.

(D) Aluminum

(1) Thickness Requirements

TABLE 901-2

ALUMINUM THICKNESS REQUIREMENTS FOR SIGNS

VERTICAL OR HORIZONTAL DIMENSION Inches	THICKNESS Inches
0-11.9	0.032
12-35.9	0.063
36-47.9	0.080
48 and larger	0.125
Milemarkers	0.080
Overlays	0.063

(2) Preparation of Aluminum Sign Surfaces

Do not handle any metal, except by appropriate handling devices or by workmen wearing clean gloves, between the beginning of the coating operations and the completion of the application of the retroreflective sheeting. Retreat aluminum sign surfaces that come into contact with grease, oils, or other contaminants prior to the application of retroreflective sheeting.

Before applying retroreflective sheeting to the aluminum, treat the aluminum sign surfaces with a chromate conversion coating. Such coating shall be applied according to the manufacturer's instruction and shall conform to ASTM B449, Class 2, and should range in color from silvery iridescent to pale yellow. The coating weight shall be 10 to 35mg per square foot (1.1 to 3.8mg per square decimeter) on the entire surface area including along the edges of the sign substrate with a median of 25mg per square foot (2.75mg per square decimeter) as the optimum coating weight. The coating shall not appear dusty when wiped with a clean, lint-free cloth and shall not show excessive buildup at edges. Sand smooth all burrs and scratches before applying retroreflective sheeting, however sheet all sanded aluminum within the same day to prevent the formation of corrosion on the metal. Do not sand or use abrasive materials on sheeted faces. Aluminum products shall be randomly tested.

(E) Supporting Frames

Use supporting frames for Types A and B signs consisting of 2 or more horizontal aluminum Z-section stringers with vertical aluminum bar stiffeners in accordance with the details and dimensions shown in the contract. Use a nylon washer to attach all through- bolts with a minimum play of 3/16”. Provide stringers with necessary holes and slots for bolting stiffeners, attaching aluminum sheet increments, and mounting to supports. Do not field drill holes in any part of the structural assembly, except the field drilling of horizontal Z-bars for attaching new signs to existing supports when necessary.

(F) Welding

Weld studs to aluminum sheets by the capacitor discharge method. Use an inert gas shielding atmosphere around the stud at the time of weld, if the manufacturer of the stud welding equipment, or studs to be used, recommends its use. If the studs are welded after the retroreflective sheeting has been applied, insure that burn-through does not damage the retroreflective sheeting.

Shoot a test stud on each Type A and B sign in the lower left corner of the most left panel facing the back of the sign.

(G) Retroreflective Sheeting

Apply retroreflective sheeting to the aluminum sign panels in accordance with the retroreflective sheeting manufacturer's recommendations. For each multi-panel increment sign using glass beaded materials, sheet the entire sign from the same roll.

If a sign panel needs to be replaced after sign fabrication, the replacement panel may be sheeted with retroreflective materials from a different lot or drum number than the remainder of the sign; however, use material that visually color matches and meets the requirements of Article 1092-2 of the *Standard Specifications*.

Take retroreflectometer readings on all four corners of each panel and document the readings on the sign design drawings.

Overlap all splices of any encapsulated or enclosed lens sheeting, to allow water to run off without running into the splice.

Remove all foreign materials on the sheeted face with compressed air.

Keep a sample of each roll of sheeting and test for retroreflective compliance.

Patch wrinkles in the sheeting around through-bolts by removing the affected sheeting from the metal. Then patch this area with a circular patch encompassing an area 1/4" outside the affected area. This patch shall not exceed the standard patching limits shown in Table 901-3.

Ensure that all patches on the sign have a 1" minimum width or as recommended by the sheeting manufacturer.

Maintain documentation of the lot, drum, inspector, roll size, date received, date sheeted and metal treater on all signs, slip sheeting, copy, borders, shields, overlays, arrows and panels, and retroreflectometer readings.

The retroreflective sheeting shall be prequalified and "Approved for Use". Obtain and assign to the Department in writing warranties for sign sheeting used in the fabrication of all permanent signs supplied by the Contractor from the Sheeting Manufacturer. Warrant the signs against defective reflective sheeting per the requirements outlined in the current signing contract held by the Department. NOTE: Permanent signs include types A, B, D, E, and F signs, overlays for all sign types, and milemarkers, and excludes any signs used only for traffic control while the project is under construction.

The reflective sheeting may be patched to repair incidental damage to the sheeting that might occur during manufacture, in transit, or after installation; however, the patches cannot exceed the limits given in the following table:

Table 901-3

Sign Patching Limits

SIGN AREA	During Fabrication		Additional Patches After Field Erection	
SQ. FT.	Max. No. Patches per sign	Max. Patch Size per Patch Sq. In.	Max. No. Patches per sign	Max. Patch Size per Patch Sq. In.
0 to 15.0	0	0	0	0
15.1 to 50.0 (Single Panel)	1	1	1	1
30.0 to 80.0 (Increment Panel)	2	2	1	2
80.1 and Greater	*	3	*	3

* Average not to exceed 1 Patch per Panel per Sign. Maximum of 3 patches per panel allowed during fabrication with one additional patch per panel allowed after field erection.

(H) Reflectorized Letters, Numerals, Symbols, Border and Shields

(1) General

Use direct-applied retroreflective sheeting or demountable retroreflective sheeting letters, numerals, borders, shields and arrows as indicated on the sign designs.

Use designs of letters and numerals that conform to the requirements of the latest edition of the *Standard Highway Signs*, prepared by the Federal Highway Administration. Use border widths, and design of route shields and arrows that conform to the requirements of the MUTCD.

Route shields used on Type A or B signs or overlays shall be demountable.

Space and size of all legends and borders as shown in the contract or in approved shop drawings. Any loose, deformed or misplaced legends and borders will be cause for rejection of the entire sign.

(2) Direct Applied

Provide direct-applied reflectorized letters, numerals, arrows, and borders that are of the type and color of retroreflective sheeting shown in the contract for each sign. All direct applied copy or border not permanently affixed may be removed and replaced on signs if necessary during manufacture.

(3) Demountable

Attach demountable letters, numerals, borders, shields, arrows, and alphabet accessories directly to sign faces with rivets, and use those that are of the type and color shown in the contract.

Use letters, numerals, arrows, borders and shields made of adhesive-coated retroreflective sheeting, permanently adhered to a flat aluminum backing, of the sheeting type and colors shown in the contract.

Use aluminum backing made of a minimum of .032" thick aluminum sheet of 3004-H38, 5052-H38 or 6061-T6 alloy. Treat with a light, tight, amorphous chromate-type coating in accordance with the recommendations of the retroreflective sheeting manufacturer. Apply the retroreflective sheeting to the properly prepared aluminum using the method and equipment prescribed by the sheeting manufacturer.

Supply each letter, numeral, arrow, border, and shield with mounting holes, and secure to the sign surface with non-twist corrosion resistant aluminum rivets. Use letters, numerals, arrows, and borders that have rivets on all sides and ends spaced not more than 6" on centers, measured along the edges. Make sure that each legend piece has at least 1 rivet in each corner and at least 2 rivets in each end. Attach route shields as part of Type A or B signs with aluminum rivets spaced a maximum of 9” apart, measured along the edges of the shield(s).

Use a 1/4” diameter nylon washer under the head of all pull through type rivets for all demountable copy and shields.

(I) Silk Screening

Apply all legends and borders on Types E & F signs by silk-screening or reverse silk-screening after the sheeting is attached to the panels. Perform all screening as recommended by the manufacturer of the retroreflective sheeting. Use the color of all legends, borders, and backgrounds, and their placement on the sign, as shown in the contract.

Use opaque black ink for nonreflectorized message application, as manufactured or recommended by the manufacturer of the retroreflective sheeting.

Use transparent ink and thinner, for application on signs reflectorized with white retroreflective sheeting, as manufactured or recommended by the manufacturer of the retroreflective sheeting. Use colors that conform to the FHWA Color Tolerance Charts and AASHTO Designation M268 when thoroughly dry.

Test all lots of transparent ink for compliance with the minimum coefficient of retroreflection equal to 70% of the specified minimum retroreflection of the corresponding sheeting color and document the retroreflection value.

(J) Mounting Hardware

Provide all mounting hardware consisting of, but not limited to, backing plates, mounting bolts, washers, shims, and nuts. Provide mounting holes in the Z stringers of the ground mounted signs in accordance with the details shown in the contract.

(K) Packaging, Shipping and Storage

Protect all signs during shipment and storage. Before shipping, make sure that all signs are free of moisture and that all inks are thoroughly dry. Do not apply adhesive tapes to any sign surface. Keep all packaged signs entirely dry.

Use assembled or partially assembled signs other than flat sheet signs that have sufficient braces securely attached to prevent buckling or warping at all times.

Affix a label outlining the retroreflective sheeting manufacturer's recommendations for handling, transporting, and storing all types of signs to each shipping carton or crate. Provide full details of such recommendations with each shipment of signs.

Label each crate or package of signs or panels as to the contents (arrows, shields, etc.), WBS Number, and sequence of packages if more than one package is for a single sign.

Maintain documentation of the lot, drum, inspector, roll size, date received, date sheeted, metal treater on all signs, slipsheeting, copy, borders, shields, overlays, arrows and panels, and retroreflectometer readings.

Individually rack or separate by foam or slip sheeting on A-frame racks all sheeted panels. Do not use spliced, overlapped, ripped or torn slipsheeting or foam.

Pack all signs standing at a seventy-five to ninety degree angle.

Turn all panels and sign faces to the inside of the crates, whenever possible.

When crating a one-panel sign, provide the face side with an extra piece of foam and cardboard taped to the outside of the face side of the package.

Pack panels of 102” in length or longer in only two per package.

Ensure all signs are debris free on the back side, with no misplaced writing, tape or extraneous sheeting.

Crate to allow a 2” space on the inside dimensions larger than the size of the largest package.

Store completed Type A and B signs back to back with minimum of 12” between faces.

When crating two panels of different sizes, place the smaller panel with its face to the back of the larger panel and package with an extra piece of foam and cardboard taped to the outside of the larger panel, with its face to the outside of the crate. Provide extra packaging on both outsides of the package for double-faced signs.

Crate packaged panels to allow the passage of a 1/8” spacer on the inside of each side of the crate, so that the panels are not overly tight or binding in crate.

The Contractor shall inspect all signs and packaging before shipping to assure compliance with the contract and Specifications. The Department retains the right to inspect the signs and packaging before shipping.

(L) Transparent Films

Use transparent films in lieu of silk screening when authorized by the Department. Transparent film is a durable, transparent, acrylic colored film coated with transparent, pressure-sensitive adhesive. When the film is applied over reflective sheeting, the coefficient of retroreflectivity shall meet the color and type of sheeting in Tables 1093-1 through 1093-9. The transparent film shall be approved by the Department and must be approved by the manufacturer of the reflective sheeting to insure the materials meet the Manufacturer's Warranty and Obligation in Section 1093-2 (F).

901-3 INSPECTION PROCEDURE

(A) General

This procedure establishes guidelines of inspection for a consistent method of inspecting the daytime appearance and nighttime reflective performance of sign sheeting. The primary function of a highway sign is to be seen by the traveling public and therefore the sign sheeting shall present a neat and balanced appearance free from visible defects.

Sheeting may be inspected before application to sign blanks, after installation to sign blanks, after completion of the sign in the sign fabricator's facility and after installation. Clean all installed signs prior to final field inspection.

(B) Daylight Visual Inspection

Under day light conditions, inspect the sign sheeting to detect color match problems, non-uniform color, streaks, spots, abrasions or other defects in the sheeting. Judge slight imperfections that may be visible at an extremely close distance and would not be visible in daytime viewing, under the nighttime inspection.

(C) Nighttime Visual Inspection

Inspect the sheeting with an inspection light while holding the inspection light at eye level and looking directly over the top of the light. Inspect to detect color match problems, non-uniform color, streaks, spots, abrasions, blistering or other defects in the sheeting.

(D) Inspection Lights

Use lights to inspect signs during fabrication that are 120 watt, 120 volt reflector flood lamp with a average rating of 1600 lumens. Use a light for field inspection that is a 50-watt, 12-volt spot lamp with a maximum output of 100,000 candlepower. In either case, use an inspection light will be bright enough to cause the sheeting to reflect, but not so bright as to cause the sheeting to be brilliantly illuminated.

(E) Silk Screening

The area supervisor will inspect the first five signs of each screening and then every fifth sign. When unacceptable signs are found, all signs shall be inspected individually.

Only three nonwets per square foot, no larger than 1/16" in diameter, covering no more than one third of the total area of the sign are allowable. This includes nonwets from either the sheeting or the screen-printing.

Only one tadpole per six square feet, no longer than 1 1/2" and not readily visible under lighted inspection is allowable.

901-4 MEASUREMENT AND PAYMENT

Sign fabrication will be measured and paid for as the actual number of square feet of sign face areas of each type, including milemarkers and overlays, that have been acceptably fabricated. In measuring this quantity, the sign face areas will be calculated to the nearest 1/100 of a square foot, using the dimensions shown in the contract.

The areas of odd-shaped signs (e.g. stop signs and shield-shaped route markers) will be calculated as squares or rectangles using the dimensions shown in the contract. The areas of round, diamond, and triangular signs will be calculated for their true shapes using plan dimensions.

Payment will be made under:

Pay Item	Pay Unit
Contractor Furnished, Type ___ Sign	Square Feet
Department Furnished, Type ___Sign	Square Feet

SECTION 902
FOUNDATIONS FOR GROUND MOUNTED SIGNS

902-1 DESCRIPTION

Construct foundations for sign supports including locating, staking, excavating, shoring, backfilling, forming, landscaping and other necessary tasks as required.

902-2 MATERIALS

Refer to Division 10:

Item	Section
Portland Cement Concrete Production and Delivery	1000
Reinforcing Steel	1070
Joint Sealer	1028-2
Select Material and Borrow Material	1016 and 1018
Organic Non-Aerosol Zinc Repair Paint	1080-9

902-3 CONSTRUCTION METHODS

Establish the proper offset, longitudinal location, and foundation elevation of each ground mounted sign support.

Provide proper level and orientation of all supports.

Thoroughly compact all backfill in 6-inch layers. Remove all unneeded excavated material from the site.

Perform all excavation necessary for foundation construction to the elevations and dimensions shown in the contract. Perform the excavation so that the sides of the excavation area conform as nearly as possible to the required dimensions. Place concrete against undisturbed soil.

Construct concrete sign foundations in accordance with Section 825. Construct either reinforced or plain Class A concrete foundations as shown in the contract. Shape the tops of the foundations to conform with finished ground elevations such that water will not collect against the supports. No construction joints will be permitted.

Form the top 6 inches of foundations by approved methods. Center the supports in the foundations, securely brace, and hold in proper position and alignment during placement of the concrete. Give the concrete an ordinary surface finish.

902-4 MEASUREMENT AND PAYMENT

The quantity of reinforced and plain concrete to be paid for will be the actual number of cubic yards of concrete that has been incorporated into the completed and accepted foundation. Computing the number of cubic yards of concrete will be done from the dimensions shown in the contract or from revised dimensions authorized by the Engineer, calculated to the nearest 1/100 of a cubic yard.

Payment will be made under:

Pay Item	Pay Unit
Reinforced Concrete Sign Foundations	Cubic Yard
Plain Concrete Sign Foundations	Cubic Yard

SECTION 903
GROUND MOUNTED SIGN SUPPORTS

903-1 DESCRIPTION

Furnish, fabricate, clear for sight distance, and install ground mounted and barrier mounted signs supports.

The types of supports covered by this section are:

A. Breakaway steel beam sign supports
B. Simple steel beam sign supports
C. 3-lb. steel U-channel posts
D. 2-lb. steel U-channel posts
E. Barrier sign support assembly
F. Wood supports
G. Steel square tube posts

903-2 MATERIALS

Refer to Division 10:

Item	Section
Breakaway or Simple Steel Beam Sign Supports (W or S Shapes)	1094-1 (A)
Signing Materials	1092
Ground Mounted Signs	1094
Steel U-Channel Posts	1094-1
Steel Square Tube Posts	1094-1
Joint Sealer	1028-2
Organic Non-Aerosol Zinc Repair Paint	1080-9

903-3 CONSTRUCTION METHODS

(A) Location and Field Verification

The support lengths and dimensions for steel and wood ground mounted supports shown in the original contract are estimated for project bid purposes.

The Engineer or contract surveyor will establish the proper offset, longitudinal location; foundation elevation and S dimension of each ground mounted and barrier mounted sign support. The Signing Section will issue a revision of the Sign Support Chart Sheet following receipt of field-verified S dimensions.

Order supports for ground mounted signs when the revised support lengths, dimensions and sizes have been determined and the appropriate plan revision is completed.

Provide the proper vertical plumb, level, and orientation of all signs and supports.

(B) Clearing for Sign Sight Distance

Clear vegetation in front of signs where necessary to achieve proper sight distance to the sign. The sight distance area includes the triangular region of land extending from the edge of the travel lane 800 feet in advance of the sign to 4 feet beyond the furthest edge of the sign from the travel lane. The Engineer will determine where clearing is required, and the amount of clearing at the sign locations. Perform the clearing in accordance with Section 200. Clearing work required outside of the original project limits will be paid for as Supplementary Clearing and Grubbing.

(C) Breakaway Steel Beam and Simple Steel Beam

Fabricate and install the supports as shown in the contract. Punch, cut, or weld supports prior to galvanizing. Galvanize each component part in accordance with ASTM A123 prior to assembly. Provide supports that are uniformly straight to within 1/8 inch tolerance for pieces less than 20 feet in length and 1/4 inch tolerance for pieces over 20 feet in length.

Cut the upper and middle sections of breakaway supports from the same member. Bolt the hinge joint in the breakaway supports to ensure true alignment of the two sections. After bolting of hinge connections make sure that the two sections are in the same position relative to each other, as prior to being cut. Completely assemble breakaway supports prior to erection.

Provide supports that are plumb. Do not shim the supports. Take adequate care during erection of supports to prevent damage to the surface finish. Use two coats of an approved organic non-aerosol zinc repair paint in touching up damaged areas on all galvanized materials.

(D) Steel U-Channel

Use 3-lb galvanized steel U-channel posts for Types D, E, and F signs. Use 2-lb galvanized steel U-channel posts for milemarkers. Use posts of sufficient length to permit the appropriate sign mounting height or splice posts if required as shown in the contract.

Drive the posts to the required depth, being sure they are plumb. Drive the posts by hand or by mechanical means. Protect the posts with an appropriate driving cap. Concrete foundations are not required. In island applications, cored holes shall be to the soil depth.

Replace any post that is bent, or otherwise damaged in driving.

Do not weld or cut supports in the field, except for the saw cutting of U-channel post material for the frames and cross-braces that may be required for Types D, E, and F signs with two or more supports.

Use two coats of an approved organic non-aerosol zinc repair paint in touching up the tops of U-channel posts that may have been damaged in driving, cut ends of U-channel posts, frames and cross-bracing, and damaged areas on these and all other galvanized materials.

(E) Barrier Supports

(1) (Small)

Attach brackets and U-channel posts to the median or shoulder barrier for the erection of Type E Signs, Type F Signs, or Milemarkers as required in the contract.

(2) (Large)

Attach brackets, anchorage and pipe posts to the median or shoulder barrier for the erection of Type E Signs as required in the contract.

(F) Wood Supports

Use wood supports as shown in the contract.

Replace any post that is damaged during erection.

Breakaway wood supports shall be drilled in accordance with the contract. All wood supports larger than 4" X 4" that have not been drilled shall be behind guardrail.

(G) Steel Square Tube Supports

Use square tube posts as shown in the contract. Use posts of sufficient length to permit the appropriate sign mounting height or splice posts if required as shown in the contract.

Drive the posts by hand or mechanical means to the required depth, being sure they are plumb. Protect the posts with an appropriate driving cap. Concrete foundations are not required. In island applications, cored holes shall be to the soil depth.

Replace any post that is bent or otherwise damaged in driving.

Do not weld or cut supports in the field.

Use two coats of an approved organic non-aerosol zinc repair paint in touching up damaged areas on the posts.

903-4 MEASUREMENT AND PAYMENT

The supports specified in this Specification that have been installed and accepted will be measured for payment as follows:

The actual number of pounds of structural steel. The computed nominal weights shown in the final revised plans will be used in determining this quantity. Measurement will not be made of the weight of nuts, bolts, and washers that are part of the sign support, as they will be considered incidental to the work.

Actual number of linear feet of 3-lb steel u-channel posts incorporated into the completed and accepted supports and assemblies. Measurements of length will be made to the nearest 1/10 of a foot.

Actual number of 2-lb steel U-channel post.

Actual number of Supports, Barrier (Small) and (Large).

Actual number of linear feet of wood support incorporated into the completed and accepted supports. Measurements of length will be made to the nearest tenth of a linear foot. The computed linear feet of sign supports, as indicated in the final revised plans will be used in determining this quantity.

Actual number of linear feet of steel square tube posts incorporated into the completed and accepted supports and assemblies. Measurements of length will be made to the nearest tenth of a foot.

Payment will be made under:

Pay Item	Pay Unit
Supports, Breakaway Steel Beam	Pound
Supports, Simple Steel Beam	Pound
Supports, 3-lb (4.5 kg) Steel U-Channel	Linear Foot
Supports, 2-lb (3 kg) Steel U-Channel	Each
Supports, Barrier (Small)	Each
Supports, Barrier (Large)	Each
Supports, Wood	Linear Foot
Supports, Steel Square Tube	Linear Foot

SECTION 904
SIGN ERECTION

904-1 DESCRIPTION

Erect existing and proposed ground mounted and overhead signs to existing and proposed supports, and furnish mounting hardware. Relocate existing signs in accordance with the contract and Specifications.

The types of signs covered by this Specification are:

1. Type A (Overhead) signs
2. Type A (Ground Mounted) signs
3. Type B (Overhead) signs
4. Type B (Ground Mounted) signs
5. Type D signs
6. Type E signs
7. Type F signs
8. Milemarkers
9. Overlay (Overhead) signs
10. Overlay (Ground Mounted) signs
11. Reposition (Overhead) signs
12. Logo Trailblazer
13. Logo to panel
14. Relocation (Ground Mounted) signs

904-2 MATERIALS

Refer to Division 10:

Item	Section
Signing Materials	1092
Organic Non-Aerosol Zinc Repair Paint	1080-9

904-3 CONSTRUCTION METHODS

(A) General

Provide new mounting bolts, washers, hex nuts, backing plates, and all hardware for all signs, existing and proposed, to be mounted on existing or proposed supports. Do not weld, cut, or fabricate in any manner in the field, except for as allowed under Section 903, and for the drilling of holes for attaching demountable legends and borders that cannot be attached in the shop. Field drill Z bars for attaching signs to supports as required.

Use two coats of an organic non-aerosol zinc repair paint in touching up field-drilled holes and damaged areas on all galvanized materials as covered under Section 903.

Make sure that the horizontal edges of signs are level, and that the faces of signs are vertical.

Refer to Sections 900 and 901 for requirements of care and handling of signs, final clean up and covering of signs.

(B) Type A and B

(1) General

Attach the signs to supports as shown in the contract or in the approved shop drawings. Make sure that the face of the sign is flat. Any appreciable buckling or warping of the sign face will be cause for rejection of the entire sign.

(2) Ground Mounted

Erect ground mounted Type A & B secondary signs by the required method of attachment shown in the contract. Affix these signs by bolting the horizontal Z stringers directly to the supports, or by bolting vertical Z bars to the horizontal Z stringers of and the primary sign.

(3) Overheads

For new overhead supports, erect overhead secondary signs as shown in the approved shop drawings.

For existing overhead supports, design and furnish all new structural members and mounting hardware necessary to erect the new signs. Prepare and submit to the Engineer for approval complete shop drawings and design computations for the bracing and accessory hardware required to attach the sign to the existing overhead sign support. Prepare the design in accordance with the *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, as published by AASHTO, the structure line drawings and wind speed shown in the contract. Upon request, the Engineer will provide the Contractor with copies of the shop drawings for existing overhead sign supports.

Attach a new sign above a designated existing overhead sign as shown in the contract. Furnish all new structural members and mounting hardware necessary to erect the new sign.

(C) Type D, E, F and Milemarkers

Attach the signs to U-channel or square tube posts as shown in the contract. Use mounting hardware as shown in the contract.

(D) Overlay (Ground Mounted and Overhead)

Attach overlays to designated existing ground mounted or overhead signs as required by the contract.

Remove and dispose of all conflicting demountable legends, borders, and overlays prior to attaching new overlays. Employ any method of removal necessary, provided it does not damage the existing sign or the attached overlay. Perform such minor repairs to existing signs as necessary prior to the attachment of overlays to ensure a finished sign face that is completely flat.

Field-drill 5/32-inch holes in both the overlay and the existing sign simultaneously, according to the rivet spacing requirements shown in the contract. Attach the proposed overlays with 1/8-inch diameter aluminum rivets of the "pull-through" type. Exercise sufficient care in attaching the overlays to ensure that the finished sign face is completely flat and without any ripples and/or buckles.

(E) Reposition Overhead Signs

Reposition existing signs on existing overhead sign supports as required by the contract. Reposition associated lighting systems and secondary signs along with the signs.

When required, drill new holes in the existing vertical attachment members, in order to maintain a minimum clearance of 17 feet to the roadway surface at the new location on the structure. No other field drilling will be allowed.

Adjust and relocate conduit and junction boxes as required.

(F) Logo Trailblazer

All logos will be made available for pick up at the Division Traffic Services' sign shop. Erect logos on U-channel or square tube posts in accordance with Type F Sign details shown in the contract.

(G) Logo to Panel

All logos will be made available for pick up at the Division Traffic Services' sign shop. Attach logos to the mainline signs with ten 1/8-inch diameter rivets of the pull through type. Attach logos to the ramp signs with four 1/8-inch diameter rivets of the pull through type. Drill 5/32-inch holes in the background signs to match those in the logos for attaching the logos to the background signs. Place logos as shown on the contract.

(H) Relocation (Ground Mounted) Signs

Maintain signs in good serviceable condition throughout the duration of the project. Repair any areas or materials within the project limits disturbed or damaged in performance of the work required under this section as directed by the Engineer at no cost to the Department.

Remove existing signs from their existing locations and relocate to their new location as required in the contract. Repair or replace signs damaged in relocating at no cost to the Department. Refer to Section 907 for disposal of sign components.

Erect signs and supports according to requirements of Sections 903 and 904. Immediately relocate all warning and regulatory signs to new locations. Relocate all other signs to new locations in no more than 12 hours.

904-4 MEASUREMENT AND PAYMENT

Sign erections (ground mounted and overhead) will be measured and paid for as actual number of ground mounted and overhead signs erected and accepted. Each type F sign assembly will be measured as one sign. Payment for signs erected on new overhead sign supports will be made in accordance with the contract Overhead Sign Supports. Walkway pay item will be used only when adding or modifying an existing overhead sign structure.

The amount of sign relocations to be paid for will be the actual number of signs that have been acceptably relocated. Secondary signs will be considered incidental work in conjunction with the primary sign. Sign assemblies consisting of more than one sign panel will be considered one sign.

Payment will be made under:

Pay Item	Pay Unit
Sign Erection, Type _____(Overhead)	Each
Sign Erection, Type _____(Ground Mounted)	Each
Sign Erection, Type _____	Each
Sign Erection, Milemarkers	Each
Sign Erection, Overlay (Overhead)	Each
Sign Erection, Overlay (Ground Mounted)	Each
Sign Erection, Reposition Overhead	Each
Sign Erection, Logo to Panel	Each
Sign Erection, Logo Trailblazer	Each
Sign Erection, Walkway	Linear Foot
Sign Erection, Relocate Type ___ (Ground Mounted)	Each

SECTION 907
DISPOSAL AND STOCKPILING OF SIGNING COMPONENTS

907-1 DESCRIPTION

Properly dispose of or stockpile signing components.

907-2 CONSTRUCTION METHODS

(A) General

Repair any areas or materials within the project limits disturbed or damaged in performance of the work required under this section as directed by the Engineer at no cost to the Department.

(B) Removal

Do not remove existing signing components until required replacements have been erected and are available for use by traffic or are available for immediate replacement.

Remove signing components by methods that will not damage other portions of the project or facility. Repair any damage by methods satisfactory to the Engineer.

Cut and remove electrical conduit to at least 18" below finished ground elevation. Plug or seal the ends of the cut conduit by methods approved by the Engineer.

Remove foundations, including any reinforced steel or anchor bolts, to a minimum depth of two feet below the finished ground elevation unless otherwise indicated by the contract.

Promptly backfill and compact areas disturbed by removal of foundations with suitable materials and match the finished ground elevation. Seed disturbed areas in accordance with Section 1661.

(C) Disposal

All materials to be removed and disposed of will become the property of the Contractor. Promptly transport the materials from the project after they have been removed unless otherwise permitted by the Engineer.

Promptly dispose of the concrete, reinforcing steel, and anchor bolts from the project.

(D) Stockpile

The Department maintains ownership of all materials to be stockpiled. Transport and stockpile designated items to location(s) approved by the Engineer. Sort and stockpile all materials neatly in stacks or storage bins.

Repair or replace materials damaged in removal or while in storage at no cost to the Department.

Prior to stockpiling, remove signs from posts.

907-3 MEASUREMENT AND PAYMENT

The amount of disposal or stockpiling to be paid for will be the actual number of signing components that have been acceptably stockpiled or disposed. Removal is incidental to stockpiling and disposal. Secondary signs will be considered incidental work in conjunction with the primary sign. Sign assemblies consisting of more than one sign panel will be considered one sign. Overhead sign systems include signs, supports, walkways and all electrical components. Sign systems include signs, supports and foundations. Supports include any foundations.

Payment will be made under:

Pay Item	Pay Unit
Disposal of Sign System, Overhead	Each
Disposal of Sign System, Steel Beam	Each
Disposal of Sign System, U-Channel	Each
Disposal of Sign System, Wood	Each
Disposal of Sign, A or B, (Ground Mounted)	Each
Disposal of Sign, A or B, (Overhead)	Each
Disposal of Sign, D, E, or F	Each
Disposal of Sign, Milemarker	Each
Disposal of Sign, Overlay (Overhead)	Each
Disposal of Sign, Overlay (Ground Mounted)	Each
Disposal of Support, Overhead Structure	Each
Disposal of Support, Steel Beam	Each
Disposal of Support, U-Channel	Each
Disposal of Support, Wood	Each
Disposal of Lighting System	Each
Disposal of Lighting Fixtures	Each
Disposal of Walkway	Each
Stockpile Sign System, Overhead	Each
Stockpile Sign System, Steel Beam	Each
Stockpile Sign System, U-Channel	Each
Stockpile Sign System, Wood	Each
Stockpile Sign, A or B, (Overhead)	Each
Stockpile Sign, A or B, (Ground Mounted)	Each
Stockpile Sign, D, E, or F	Each

Stockpile Sign, Milemarker	Each
Stockpile Support, Overhead Structure	Each
Stockpile Support, Steel Beam	Each
Stockpile Support, U-Channel	Each
Stockpile Support, Wood	Each
Stockpile Lighting System	Each
Stockpile Lighting Fixtures	Each
Stockpile Walkway	Each

DIVISION 10
MATERIALS

SECTION 1000
PORTLAND CEMENT CONCRETE
PRODUCTION AND DELIVERY

1000-1 DESCRIPTION

This section addresses portland cement concrete to be used for pavement, precast construction, incidental construction, and structures. Produce and deliver portland cement concrete to where it is incorporated into the work.

Produce portland cement concrete composed of portland cement, fine and coarse aggregates, water, and, optionally, a pozzolan. Type IP blended cement or Type IS blended cement may be used in lieu of portland cement, and fly ash, ground granulated blast furnace slag, or silica fume may be substituted for a portion of the portland cement. In addition, add an air entraining agent and/or other chemical admixtures if required or permitted by these Specifications. Use the class of portland cement concrete required by the contract, and proportion, mix, and deliver in accordance with the requirements contained herein.

Mixes for all portland cement concrete covered by this section shall be designed by a Certified Concrete Mix Design Technician.

When concrete being placed in any one pour is furnished by more than one concrete plant, use the same mix design for all concrete, including sources of cement, sand, stone, pozzolan, and all admixtures.

1000-2 MATERIALS

Refer to Division 10:

Item	Section
Coarse Aggregate	1014-2
Fine Aggregate	1014-1
Portland Cement	1024-1
Type IP Blended Cement	1024-1
Fly Ash	1024-5
Type IS Blended Cement	1024-1
Ground Granulated Blast Furnace Slag	1024-6
Silica Fume	1024-7
Water	1024-4
Air Entraining Agent	1024-3
Chemical Admixtures	1024-3
Calcium Nitrite Corrosion Inhibitor	1024-3

1000-3 PORTLAND CEMENT CONCRETE FOR CONCRETE PAVEMENT

(A) Composition and Design

Submit concrete paving mix design in terms of saturated surface dry weights on M&T Form 312U for approval a minimum of 30 days prior to proposed use.

Use a mix that contains a minimum of 526 pounds of cement per cubic yard, a maximum water cement ratio of 0.559, an air content in the range of 4.5 to 5.5 percent, a maximum slump of 1.5" and a minimum flexural strength of 650 psi at 28 days.

The cement content of the mix design may be reduced by a maximum of 20% and replaced with fly ash at a minimum rate of 1.2 pounds of fly ash to each pound of cement replaced. Use a maximum water-cementitious material ratio not to exceed 0.538.

The cement content of the mix design may be reduced by a maximum of 50% and replaced with blast furnace slag pound for pound.

Include in the mix design the source of aggregates, cement, fly ash, slag, and admixtures; the gradation and specific gravity of the aggregates; the fineness modulus (F.M.) of the fine aggregate; and the dry rodded unit weight and size of the coarse aggregate. Submit test results showing that the mix design conforms to the criteria, including the 28-day flexural strength of a minimum of 6 beams made and tested in accordance with AASHTO T126 and AASHTO T97. Design the mix to produce an average flexural strength sufficient to indicate that a minimum strength of 650 psi will be achieved in the field.

Where concrete with a higher slump for hand methods of placing and finishing is necessary, submit an adjusted mix to provide a maximum slump of 3" and to maintain the water-cementitious material ratio established by the original mix design.

(B) Air Entrainment

Entrain air in the concrete by the use of an approved air entraining agent dispensed with the mixing water, unless prohibited.

Provide an air content of 5.0 percent plus or minus 1.5 percent in the freshly mixed concrete. The air content will be determined in accordance with AASHTO T152, T121, or T196. At the option of the Engineer, the air content may be measured by the Chace indicator, AASHTO T199, in which case sufficient tests will be made in accordance with AASHTO T152, T121, or T196 to establish correlation with the Chace indicator. Concrete will not be rejected based on tests made in accordance with AASHTO T199.

(C) Slump

Provide concrete with a maximum slump of 1½" where placed by a fully mechanized paving train and a maximum of 3" where placed by hand methods.

The sample taken for determination of slump will be obtained immediately after the concrete has been discharged onto the road.

(D) Set Retarding Admixture

With permission, the Contractor may use an approved set retarding admixture to facilitate placing and finishing.

Use a quantity of set retarding admixture within the range shown on the current list of approved admixtures maintained by the Materials and Tests Unit.

(E) Water Reducing Admixtures

With permission, the Contractor may use an approved water reducing admixture to facilitate placing and finishing.

Use a quantity of water reducing admixture within the range shown on the current list of approved admixtures maintained by the Materials and Tests Unit.

(F) Contractor's Responsibility for Process Control

Control the materials and operations to produce uniform pavement that meets specification requirements. Submit a plan detailing the process control and the type and frequency of testing and inspection necessary to produce concrete that meets the Specifications. Submit this plan at the preconstruction conference. Perform sampling, testing, and inspection necessary to provide adequate process control. During all batching and delivery operations assign a Certified Concrete Batch Technician on site whose sole duty is to supervise the production and control of the concrete. This duty includes the following:

(1) Tests and inspections necessary to maintain the stockpiles of aggregates in an unsegregated and uncontaminated condition.

(2) Calibration of admixture dispensing systems, weighing systems, and water gages.

(3) Tests and adjustments of mix proportions for moisture content of aggregates.

(4) Mixer performance tests prior to reducing mixing time of central mix plant to less than 90 seconds and at other times when deemed necessary by the Engineer.

(5) Verifying the actual mixing time of the concrete after all materials are introduced into the mixer at the beginning of paving operations and at least once each month.

(6) Testing all vibrators.

(7) Tests necessary to document the slump and air content of the mix produced. Determine air content at least twice each day.

(8) Tests for depth of the pavement in the plastic state.

(9) Furnishing data to verify that the approved theoretical cement content has been met at intervals not to exceed 50,000 square yards of pavement.

(10) Signing all plant reports, batch tickets, and delivery tickets.

The Department certifies technicians who satisfactorily complete examinations prepared and administered by the Division of Highways.

Perform all test procedures in compliance with the appropriate articles of Section 1000.

Tests may be witnessed by the Engineer. Document the results of all tests and inspections and make a copy available to the Engineer upon request. Take prompt action to correct conditions that have resulted in or could result in the submission of materials, products, or completed construction that do not conform to the requirements of the Specifications.

(G) Contractor Not Relieved of Responsibility for End Result

The Contractor will not be relieved of his obligation to produce a uniform pavement meeting Specifications by reason of:

(1) The acceptance or approval by the Engineer of the concrete mix design or any adjustments;

(2) Compliance with the concrete mix design and compliance with the testing requirements and other process control requirements by the Contractor; or

(3) The failure of the Engineer to perform any tests in the process control, nor the performance of any tests in the process control that indicate compliance with the Specifications.

1000-4 PORTLAND CEMENT CONCRETE FOR STRUCTURES AND INCIDENTAL CONSTRUCTION

(A) Composition and Design

Provide the class of concrete required by the contract.

Submit proposed concrete mix designs for each class of concrete to be used in the work. Mix proportions shall be determined by a testing laboratory approved by the Department. Base mix designs on laboratory trial batches that meet the requirements of Table 1000-1 and other applicable sections of these Specifications. Determine quantities of fine and coarse aggregate by ACI 211, *Recommended Practice for Selecting Proportions for Normal Weight Concrete*, using the absolute volume basis.

Submit mix designs in terms of saturated surface dry weights on M&T Form 312U at least 35 days prior to proposed use. Adjust batch proportions to compensate for surface moisture contained in the aggregates at the time of batching. Changes in the saturated surface dry mix proportions will not be permitted unless revised mix designs have been submitted to the Engineer and approved.

Accompany M&T Form 312U with a listing of laboratory test results of aggregate gradation, air content, slump, and compressive strength. List the compressive strength of at least three 6" x 12" or 4" x 8" cylinders at the age of 7 and 28 days.

Perform laboratory tests in accordance with the following test procedures:

Aggregate Gradation	AASHTO T27
Air Content	AASHTO T152
Slump	AASHTO T119
Compressive Strength	AASHTO T23 and T22

The Engineer will review the mix design for compliance with the Specifications and notify the Contractor as to its acceptability. Do not use a mix until written notice has been received. Acceptance of the mix design does not relieve the Contractor of his responsibility to furnish a product that meets Specifications. Upon written request from the Contractor, a mix design accepted and used satisfactorily on any Department project may be accepted for use on other projects.

(B) Air Entrainment

Entrain air in the concrete unless otherwise indicated on the plans or in the Specifications. Add an air entraining agent at the time of mixing to produce an air content in the freshly mixed concrete of 6.0 percent plus or minus 1.5 percent when tested at the job site. Determine the air content in accordance with AASHTO T152, T196, or T121. Measurement of air content may also be performed by the Chace indicator in accordance with AASHTO T199, in which case sufficient tests will be made in accordance with AASHTO T152, T121 or T196 to establish correlation with the Chace indicator. Concrete for structures will not be rejected based on tests made in accordance with AASHTO T199. Concrete for incidental construction may be rejected based on an average of 3 or more tests made in accordance with AASHTO T199.

Air entraining agent may be added at the job site when permitted by the Engineer.

(C) Strength of Concrete

The compressive strength of the concrete will be considered the average compressive strength test results of two 6" x 12" cylinders, or two 4" x 8" cylinders if the aggregate size is not larger than size 57 or 57M. Make cylinders in accordance with AASHTO T23 from the concrete delivered to the work. Make cylinders at such frequencies as the Engineer may determine and cure them in accordance with AASHTO T23 as modified by the Department. Copies of these modified test procedures are available upon request from the Materials and Tests Unit.

Table 1000-1

Requirements For Concrete

Class of Concrete	Minimum compressive Strength at 28 days, psi	Maximum Water-Cement Ratio				Consistency Max. Slump, Inches		Min. Cement Content, Lbs/Yd^3	
		Air-Entrained Concrete		Non Air-Entrained Concrete		Vibrated	Non-Vibrated	Vibrated	Non-Vibrated
		Rounded Aggregate	Angular Aggregate	Rounded Aggregate	Angular Aggregate				
AA	4500	0.381	0.426	---	---	3.5	---	639 - 715	---
AA Slip Form	4500	0.381	0.426	---	---	1.5	---	639 - 715	---
Drilled Pier	4500	---	---	0.450	0.450	---	5 - 7 dry / 7 - 9 wet	---	640 - 800
A	3000	0.488	0.532	0.550	0.594	3.5	4	564	602
B	2500	0.488	0.567	0.559	0.630	2.5	4	508	545
B Slip Formed	2500	0.488	0.567	---	---	1.5	---	508	---
Sand Lightweight	4500	---	0.420	---	---	4	---	715	---
Latex Modified	3000 (7day)	0.400	0.400	---	---	6	---	658	---
Flowable Fill excavatable	150 (max. @ 56 days)	as needed	as needed	as needed	as needed	---	flowable	---	40
Flowable Fill non-excavatable	125	as needed	as needed	as needed	as needed	---	flowable	---	100
Pavement	650 (flexural)	0.559	0.559	---	---	1.5 slip form / 3.0 hand placed		526	---
Precast	See Table 1077-1	as needed	as needed	---	---	8	as needed	as needed	as needed
Prestress -6000	6000 or less	0.450	0.450	---	---	8		564	---
Prestress +6000	greater than 6000	0.400	0.400	---	---	8		564	---

When the average compressive strength of the concrete test cylinders is less than the minimum strength specified in Table 1000-1 and the Engineer determines it is within reasonably close conformity with strength requirements, concrete strength will be considered acceptable. When the Engineer determines average cylinder strength is not within reasonably close conformity with specified strength, the in-place concrete will be tested. Based on these test results, the concrete will either be accepted with no reduction in payment or accepted at a reduced unit price or rejected as set forth in Article 105-3.

(D) Temperature Requirements

The concrete temperature at the time of placing in the forms shall be not less than 50°F nor more than 95°F except where other temperatures are required by Articles 420-8, 420-9 and 420-15.

Do not place concrete without permission when the air temperature measured at the location of the concrete operation in the shade away from artificial heat is below 35°F. When such permission is granted, uniformly heat the aggregates and/or water to a temperature not higher than 150°F. Do not place heated concrete in the forms if the temperature is less than 55°F or more than 80°F.

(E) Elapsed Time for Placing Concrete

Deliver concrete to any monolithic unit of a structure at a rate that will permit proper handling, placing, and finishing of the concrete. Regulate the delivery so that the maximum interval between the placing of batches at the work site does not exceed 20 minutes.

Place concrete before the time between adding the mixing water to the mix and placing the concrete in the forms does not exceed that set forth in Table 1000-2.

(F) Use of Set Retarding Admixtures

Use an approved set retarding admixture in all concrete placed in the superstructure of bridges such that the concrete will remain workable until the entire operation of placing and finishing, including corrective measures, if necessary, has been completed. The Engineer may waive the use of set retarding admixture when conditions clearly indicate that it is not needed.

TABLE 1000-2
ELAPSED TIME FOR PLACING CONCRETE

Air or Concrete Temperature Whichever is Higher	Maximum Elapsed Time	
	No Retarding Admixture Used	Retarding Admixture Used
90°F or above	30 minutes	1 hr. 15 minutes
80°F through 89°F	45 minutes	1 hr. 30 minutes
*79°F or below	60 minutes	1 hr. 45 minutes
**70°F through 79°F	60 minutes	1 hr. 45 minutes
**69°F or below	1 hr. 30 minutes	2 hr. 15 minutes

* Applicable to Class AA and A concrete.
** Applicable to Class B concrete.

Other structural concrete may also contain an approved set retarding admixture when permitted by the Engineer.

Use a quantity of set retarding admixture within the range shown on the current list of approved admixtures issued by the Materials and Tests Unit.

(G) Use of Water Reducing Admixtures

By permission of the Engineer, the Contractor may use an approved water reducing admixture to facilitate placing and finishing.

Use a quantity of water reducing admixture within the range shown on the current list of approved admixtures issued by the Materials and Tests Unit.

(H) Use of Calcium Chloride

Calcium chloride may be used as a set accelerating agent where permitted by the Engineer. Use 1 lb. of calcium chloride per 100 lb. of cement except where lesser amounts are directed. Do not use calcium chloride where steel reinforcement, metal conduit, or other metals will be in contact with the concrete. Do not use calcium chloride in concrete that has a temperature higher than 70°F, or when the air temperature is greater than 70°F. Provide cold weather protection for concrete containing calcium chloride in the same manner as is provided for concrete without calcium chloride.

Use calcium chloride in liquid form. Use a solution of 1 pound or less of calcium chloride per 1 quart of water, and mix well. To avoid incompatibility with other additives, add the calcium chloride to the batch after all other ingredients have been put into the mixer.

(I) Use of Fly Ash

Unless otherwise specified, fly ash may be substituted for portland cement in all classes of concrete at a rate not to exceed 20% by weight of the required cement noted in Table 1000-1. Unless otherwise specified, substitute at least 1.2 pounds of fly ash per pound of cement replaced. Do not substitute fly ash for a portion of Type IP or IS cement or for portland cement in high early strength concrete.

Use the following table to determine the maximum allowable water-cementitious material (cement + fly ash) ratio for the classes of concrete listed. For all other classes, the maximum water-cementitious material ratio will be the same as the water-cement ratio listed in Table 1000-1.

	Maximum Water-Cementitious Material Ratio	
Class of Concrete	**Rounded Aggregate**	**Angular Aggregate**
AA & AA Slip Form	.366	.410
A	.469	.512
B & B Slip Form	.469	.545
Pavement	.538	.538

(J) Use of Ground Granulated Blast Furnace Slag

Unless otherwise specified, slag may be substituted pound for pound for portland cement in all classes of concrete at a rate not to exceed 50% by weight of the required cement. Do not exceed the water-cement ratio shown in Table 1000-1. Do not substitute slag for a portion of Type IP or IS cement or for portland cement in high early strength concrete.

(K) Use of Calcium Nitrite Corrosion Inhibitor

Units with calcium nitrite in a quantity less than specified are subject to rejection. Furnish concrete cylinders to the Engineer, in a quantity to be specified, to verify the concentrations of calcium nitrite in hardened concrete. Concrete that fails to contain calcium nitrite at the required concentrations as tested is subject to rejection. Use air-entraining, water-reducing, and/or set-controlling admixtures compatible with calcium nitrite solutions. Strictly adhere to the manufacturer's written recommendations regarding the use of admixtures, including storage, transportation and method of mixing. If preferred, use calcium nitrite, which acts as an accelerator, in conjunction with a retarder to control the set of concrete, as per the manufacturer's recommendation. Add an approved calcium nitrite corrosion inhibitor (30% solids) to the concrete mix at the batch plant for the bridge elements identified by the plan notes. Use the inhibitor at a minimum rate of 3.0 gal/yd^3. Ensure that the hardened concrete contains at least 5.1 lbs/yd^3 nitrite (NO_2) when tested in accordance with Materials and Tests Method Chem. C-20. The preceding paragraph does not apply to concrete used in prestressed concrete members. Concrete used in prestressed concrete members shall be tested in accordance with 1078-4(G).

1000-5 CONCRETE FOR MACHINE PLACED CURB, CURB AND GUTTER, AND PAVED DITCH

Use Class B Slip Form.

1000-6 HIGH EARLY STRENGTH PORTLAND CEMENT CONCRETE

Use high early strength portland cement concrete when required by contract. When not required, it may be used at the Contractor's option with approval of the Engineer.

For all classes of concrete, high early strength concrete may be produced by using Type III portland cement. To produce high early strength concrete with regular cement, use a higher class of concrete as follows:

> For Class A and Class B, use Class AA with a minimum cement content of 677 pounds per cubic yard; for Class B Slip Form, use Class AA Slip Form with a minimum cement content of 677 pounds per cubic yard. Other classes that lend themselves to high early strength with regular cement will be reviewed by the Engineer on a case-by-case basis.

1000-7 FLOWABLE FILL

Flowable fill consists of portland cement, water, pozzolan and/or fine aggregate, and, optionally, conventional concrete admixtures and/or a high-air entraining agent or foaming agent. Use it for filling underground storage tanks and pipe culverts and for backfilling culverts, bridge substructures, retaining walls, roadway trenches and for other applications where conventional fill material has traditionally been used.

1000-8 LATEX MODIFIED CONCRETE

(A) Materials Use materials that meet the requirements for the respective items in the *Standard Specifications* with the following exceptions:

Cement - Do not use Type III (high early strength).

Aggregate – Follow Section 1014 of the *Standard Specifications*, except provide coarse aggregate that meets the gradation for standard size No. 78M.

Fine Aggregate – Follow the *Standard Specifications***.**

Latex Emulsion Admixture – Use a formulated latex admixture that is a non-hazardous, film forming, polymeric emulsion in water and is homogeneous and uniform in composition. Add all stabilizers at the point of manufacture.

Use a latex modifier conforming to the following requirements:

Polymer Type	Styrene Butadiene
	68 ±4% Styrene
	32 ±4% Butadiene
Average Polymer Particle Size	1500 to 2500 Angstroms
Emulsion Stabilizers	Anionic and non-ionic surfactants
Percent Solids	46.5 to 49.0
Weight per gallon, lbs at 75°F	8.40 to 8.60
pH	9.5 to 11.0

Shelf Life	2 Years
Color.	White

Provide a Type 5 Supplier's Certification for each load of latex emulsion admixture in accordance with Article 106-3 of the *Standard Specifications*. Test admixture samples to verify compliance with the specification requirements before use. Allow 7 days for sampling and testing after delivery to the project.

Do not allow the temperature of latex emulsion admixture to fall below 35°F at any time or exceed 85°F after delivery to the project.

For latex emulsion that has been in storage, use a transfer pump and lines to recirculate it before using.

Latex Modified Concrete – Use a workable mixture that meets the following requirements:

Cement Content, lbs/yd^3	658
Latex Emulsion Admixture, gal/yd^3	24.5
Air Content of Plastic Mix, %	3.5 - 6.5
Slump, inches	3 – 6
% Fine Aggregate as percent of total aggregate by weight	50 - 55
Minimum 7 day compressive strength, psi	3000
Water-Cement Ratio by weight, maximum	0.40

Measure the slump 4 to 5 minutes after discharge from the mixer.

Submit the latex modified concrete mix design, completed by the latex emulsion manufacturer, to the Engineer for review.

(B) Equipment Prior to beginning any work, obtain approval for all equipment to be used for deck preparation, mixing, placing, finishing, and curing the latex modified concrete.

Use sandblasting equipment capable of removing all clay, salt deposits, oil and grease deposits and all other foreign matter. Provide traps or separators to remove oil and water from the compressed air. Use traps or separators of adequate size and drain them periodically during operations. For proportioning and mixing, use self-contained, mobile, and continuously mixing equipment that meets the following requirements:

Use a self-propelled mixer that is capable of carrying sufficient unmixed dry, bulk cement, sand, coarse aggregate, latex modifier, and water to produce at least 6 yd^3 of concrete on site.

Use a mixer that is capable of positive measurement of cement introduced into the mix. Use a recording meter that is visible at all times and equipped with a ticket printout to indicate the quantity of cement.

Calibrate the mixers to accurately proportion the specified mix. Prior to placing latex modified concrete, perform calibration and yield tests under the Engineer's supervision in accordance with the Department's written instructions. Copies of these written instructions are available from the Materials and Tests Unit. Perform the calibration and yield tests using the material to be used on the project. Recalibrate the mixer after any major maintenance operation, on the mixer, anytime the source of materials changes, or as directed. Furnish all materials and equipment necessary to perform the calibrations and yield tests.

Use a mixer that controls the flow of water and latex emulsion into the mix. Measure the flow rate of water and the latex emulsion with a calibrated flowmeter coordinated with both the cement and aggregate feeding mechanisms and the mixer. Adjust the flow rate, as necessary, to control the slump and ensure that the water-cement ratios are met. In addition to flowmeters, use mixers with accumulative water and latex meters capable of indicating the number of gallons, to the nearest 0.1 gallon, introduced into the mixer. Filter water and latex with a suitable mesh filter before it flows through the accumulative water and latex meters.

Calibrate the mixer to automatically proportion and blend all components of the indicated composition on a continuous or intermittent basis as the finishing operation requires. Provide a mixer that discharges mixed material through a conventional chute and is capable of spraying water over the placement width as it moves ahead to ensure that the surface to be overlaid is wet prior to receiving the modified material.

Mount a tachometer on the unit to indicate the drive shaft speed.

Use adequate hand tools for placing and leveling concrete down to approximately the correct level for striking off with the screed.

Use a finishing machine that meets the approval of the Engineer and the requirements of the contract. Use a self-propelled finishing machine capable of forward and reverse movement under positive control. Use a machine with at least two finishing devices, one that is a vibrating screed and the other either a vibrating screed, oscillating screed, or one or more rotating cylindrical drums 48 inches long or less and operating between 1500 and 2500 vpm. Make certain the finishing machine can finish the surface to within 1 foot of the edges of the area being placed. Raise all screeds when the finishing machine is moving backwards over the screeded surface.

Use screeds with a vibration frequency that is variable between 3,000 and 6,000 vpm with positive controls. Use screeds with a metal covered bottom face not less than 4 inches wide. Provide screeds with positive control of the vertical position.

Use supporting rails for travelling of the finishing machine rigid enough to eliminate deflection from the weight of the machine.

Proportioning and Mixing of Modified Compositions

Meet the following requirements when proportioning and mixing modified materials:

Use mobile continuous mixers that accurately proportion all materials for the specified mixture. Operate the proportioning equipment at the manufacturer's

recommended speed verified with the tachometer during calibration and normal operations.

Yield checks and other checks are permitted.

1000-9 MEASURING MATERIALS

(A) Weighing Cement

Measure cement by weight on scales separate from those used for other materials, and in a hopper entirely free and independent of the hoppers used for weighing the aggregates. When the quantity of cement in a batch exceeds 30 percent of the full capacity of the scale, have the quantity of cement as indicated by the scale be within plus or minus 1 percent of the required weight. For smaller batches, have the quantity of cement as indicated by the scale be not less than the required amount or more than 4 percent in excess. Equip all beam type scales with a tare beam.

(B) Weighing Aggregates

Measure aggregates by weight. Base batch weights on saturated surface dry materials and which are the required weights plus the total weight of surface moisture contained in the aggregates. Have the individual aggregates, as weighed, be within plus or minus 2 percent of the required weights.

(C) Water

Measure water by volume or by weight. Have the quantity of water measured be within plus or minus 1 percent of the required amount.

(D) Admixture Dispensing Systems

Provide a separate dispensing system with separate fill and discharge lines for each type of admixture to be used, except that admixtures may be measured and introduced into the mix manually if approval has been obtained. Have each system be capable of measuring, displaying, and discharging the required amount of admixture into the mix. Keep dispensing systems clean and in good operating condition. Use a dispensing system that is either:

(1) Manually operated, self contained; or

(2) Semi automatic or automatic, self contained; or

(3) Interfaced to operate automatically with the concrete batching control panel.

Have the admixture dispenser dispense the required quantity of admixture for each concrete batch within an accuracy of plus or minus 3 percent. Check the accuracy of the dispenser as provided below. Check the accuracy at the point of discharge, or through a bypass valve suitable for obtaining a calibrated sample of admixture and at the volumes normally used for one half mixer capacity and for full mixer capacity. Determine the accuracy at the time of installation, and check daily during the early part of each day's operation.

Include in each system a graduated measuring unit into which the admixture is batched to permit a quick visual check of accuracy prior to its discharge.

Have the measuring unit be clearly graduated and be of sufficient size to hold the maximum anticipated dose for 1 batch. Clearly mark the measuring unit for the type of admixture to be used.

Control the discharge sequence so that an admixture will not be brought into contact with raw cement or another admixture before being diluted through contact with the mixing water in the mixer. Where 2 types of admixtures are being used, do not discharge them into the mix simultaneously. Add the air entraining agent with the first addition of water and add any other chemical admixture with the final addition of water, unless otherwise permitted.

Construct the discharge lines to completely empty after each cycle. Locate the admixture dispensing systems so that the batching plant operator will have a visual verification of the actual quantity of admixture batched.

Use air entraining admixtures in accordance with the manufacturer's recommendations and in such quantity to provide the specified air content in freshly mixed concrete. Use a quantity of set retarding admixture and of water reducing admixture per 100 lb. of cement that is within the range recommended on the current list of approved admixtures issued by the Materials and Tests Unit.

1000-10 BATCHING PLANT

(A) General

Plants located on the Department rights-of-way shall conform to the requirements of Article 107-3.

Have ready mixed concrete plants inspected and approved by the Department before they are used to produce concrete, either paving, structural or incidental, for the project. Have plants meet all the applicable requirements of the Specifications, and in addition have each ready mix plant provide at least 3 acceptable truck mixers or truck agitators available for use. Use trucks that have an identifying number. Plants approved by the Department will be placed on a list of approved plants that will be made available to the Contractor. All plants will be subject to reinspection at intervals selected by the Engineer. Re-approval after each inspection will be contingent on continuing compliance with the Specifications.

(B) Bins and Hoppers

Provide bins with separate compartments for fine aggregates and for each required size of coarse aggregate in the batching plant. Design each compartment to discharge efficiently and freely into the weighing hopper. Provide control so that, as the quantity desired is being approached, the material may be added slowly and shut off with precision. Construct weighing hoppers to eliminate accumulation of tare materials and to discharge fully unless otherwise permitted. Provide a port or other opening for removing an overload of any one of the several materials from the hopper.

(C) Scales

Use either the beam type, load cell type or the springless dial type scales for weighing aggregates and cement. Have the minimum graduation on beam or dial be not more than 0.1 percent of the total capacity of the scale. Methods of weighing, other than beam or springless dial scales, may be approved by the Engineer provided they meet the required weighing tolerances. Have the scales be accurate within 0.5 percent under operating conditions. Make available ten 50 pound test weights at the plant for checking accuracy. Use test weights which meet the US Bureau of Standards requirements for calibrating and testing equipment. Keep all exposed fulcrums, clevises, and similar working parts of scales clean. When beam type scales are used, make provisions for indicating to the operator that the required load in the weighing hopper is being approached. Have the device indicate at least the last 50 pounds of load, and design it to give a positive indication of overload of the scales. During charging of the hopper, have all indicating devices in full view of the operator and provide convenient access to all controls. Have the indicating devices in the immediate vicinity of the operator so that they are easily readable by the operator.

(D) Water Measuring Devices

Use devices for measurement of the water which are readily adjustable and are capable of being set to deliver the required amount and cut off the flow automatically when this amount has been discharged. Under all operating conditions the device shall have accuracy within 1 percent of the quantity of water required for the batch. Arrange the device so that variable pressures in the water supply line will not affect the measurements. Use measuring tanks of adequate capacity to furnish the maximum mixing water required and equip them with outside taps and valves to provide for checking their calibration unless other means are provided for readily and accurately determining the amounts in the tank.

1000-11 MIXERS AND AGITATORS

(A) General

Mixers are defined as equipment to mix concrete and may be stationary or truck mounted. Agitators are defined as equipment used to haul central mixed concrete and may be truck mixers or truck agitators. Provide a metal plate or plates attached to each mixer and agitator in a prominent place on which the manufacturer has plainly marked the mixing speed of the drum or paddles and the maximum capacity of the drum or container in terms of volume of mixed concrete. On truck mixers and agitators, show the manufacturer's recommended agitating and mixing speed of rotation of the mixing drum or blades. Equip stationary mixers with an acceptable timing device that will not permit the batch to be discharged until the specified mixing time has elapsed. Equip truck mixers with counters to verify the number of revolutions of the drum or blades. Actuate the counters at the initial time the drums have reached mixing speed.

Examine mixers and agitators periodically for changes in condition due to accumulation of hard concrete or mortar, wear of blades, or any other condition which decreases mixing efficiency. Mixers are unacceptable when the radial height

or other dimension of the blade has worn below 90 percent of the original dimension. This radial height does not include any lips on the blade, and is the height of the blade running perpendicular to the shell of the drum. Where such conditions are found, do not use the units until they are corrected.

Also examine mixers and agitators periodically for general mechanical condition, including water measuring and discharge apparatus, identifying number on trucks, condition of the blades, speed of rotation of the drum, and condition of the drum.

(B) Mixer Capacity

Do not load truck mixers with concrete with more than 63 percent of the gross volume of the drum. Use mixers capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity. Use stationary mixers, when loaded at the manufacturer's guaranteed mixing capacity and the concrete mixed for the prescribed mixing time, capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass and discharging the concrete with satisfactory uniformity.

Use at least 20 percent of the rated mixing capacity as the minimum quantity of concrete permitted to be mixed or agitated in any mixer.

(C) Agitator Capacity

Load the agitator to not exceed 80 percent of the gross drum volume and have it be capable of maintaining the concrete in a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

(D) Consistency Tests

The Engineer may, from time to time, make slump tests to measure consistency of the concrete. Take individual samples at approximately the 1/5th point, the midpoint, and the 4/5th point of the load, using AASHTO T119. Such tests will be made within 20 minutes of discharge of that portion of the load. If the results vary by more than 1" in slump, do not use the mixer or agitator unless the condition is corrected.

1000-12 MIXING AND DELIVERY

(A) General

Mix and deliver concrete to the site of the work by one of the following methods, except where other methods are approved. Maintain responsibility for controlling the materials and operations as to produce uniform concrete meeting Specifications requirements.

When concrete is being produced for structures and incidental construction in accordance with the requirements of Article 1000-4, have present during all batching operations a Certified Concrete Batch Technician employed by the Contractor or concrete supplier. During batching and delivery, the sole duty of this employee is to supervise the production and control of the concrete. Perform moisture tests, adjust mix proportions of aggregates for free moisture, complete and sign Batch Tickets (M & T Form 903) or approved delivery tickets, and assure quality control of the batching. Delivery tickets will be permitted in lieu of batch tickets (M & T

Form 903) provided they have been reviewed and approved by the Materials and Tests Unit. The Division of Highways certifies technicians who satisfactorily complete examinations prepared and administered by the Division of Highways.

(1) Central Mixed Concrete

Concrete that is mixed completely in a stationary mixer and the mixed concrete transported to the point of delivery in a truck agitator or in a truck mixer operating at agitating speed or in non agitating equipment approved by the Engineer. Perform mixing within the capacity and at the mixing speeds recommended by the manufacturer.

(2) Transit Mixed Concrete

Concrete that is mixed completely in a truck mixer while at the batching plant, in transit, or at the work site.

(3) Shrink Mixed Concrete

Concrete that is mixed partially in a stationary mixer at a central mixing plant and completed as transit mixed concrete. Place all ingredients for a batch in the stationary mixer and partially mix before any concrete is discharged to the truck mixer, and do not exceed the rated capacity of the equipment for the batch size. The mixing time at the stationary mixer may be reduced to the minimum necessary to intermingle the ingredients, and the mixing completed in the truck mixer. Use the number of mixing revolutions in the truck mixer as specified for transit mixed concrete or reduce as indicated by mixer performance tests.

(B) Mixing Time for Central Mixed Concrete

Mixing time begins when all solid materials are in the mixing compartment and ends when any part of the concrete begins to discharge. In charging the mixer water will enter in advance of cement and aggregate, and have substantially all the water in the drum before one-third of the specified mixing time has elapsed. Count transfer time in multiple drum mixers as part of the mixing time.

Where mixer performance tests are not made, use a minimum mixing time of 90 seconds, providing that blending of materials during charging is achieved to the satisfaction of the Engineer. The minimum mixing time for an individual mixer is that which, as shown by mixer performance tests, will produce concrete meeting the requirements of Table 1000-3, except that the mixing time shall not be less than 50 seconds under any circumstances. Maximum mixing time excluding discharge time is 150 seconds.

Sampling and testing for mixer performance tests will be done as provided below. Charge the mixer to its rated capacity with the materials and proportions to be used in the work and mixed at the recommended mixing speed to the target time. Stop mixing and begin discharging. Two samples of sufficient size to make the required tests will be taken after discharge of approximately 15 and 85 percent of the load.

TABLE 1000-3

REQUIREMENTS FOR UNIFORMITY OF CONCRETE

Tests	Maximum Permissible Difference in Test Samples
Air content, percent by volume of Concrete (AASHTO T152)	1.0%
Slump, inches (AASHTO T119)	1.0"
Coarse aggregate content, portion by weight of each sample retained on the No. 4 sieve, percent (AASHTO M157)	6.0%
Weight per cubic foot (AASHTO T121)	1.0 lb.
Average compressive strength at 7 days, percent of average (AASHTO T22 and T23)	10.0%*

* Tentative approval may be granted pending 7 day compressive strength tests.

Each of the 2 samples of concrete will be separately tested for the properties listed in Table 1000-3. Tests will be conducted in accordance with the test procedures specified in Table 1000-3 or procedures established by the Materials and Tests Unit.

The mixer performance test described above will be performed on a minimum of 2 batches of concrete. For the performance test to be acceptable, have all tests in each batch tested meet the requirements listed above.

The Engineer may recheck mixer performance at any time when in his opinion satisfactory mixing is not being accomplished.

Where satisfactory mixing cannot be accomplished in 90 seconds, the Engineer may increase the mixing time or require that the mixer be repaired or replaced before any further mixing can be done.

(C) Mixing; Truck Mixers and Truck Agitators

When a truck mixer is used for complete mixing, mix each batch of concrete for at least 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as mixing speed, unless otherwise directed by the Engineer. Unless the mixer is equipped with a counter which will distinguish between mixing and agitating speeds, perform the minimum required number of revolutions of the drum at mixing speed as directed, either at the batching plant before the mixer leaves for the work site and/or at the work site before the concrete is discharged. Perform any additional mixing at the speed designated by the

manufacturer of the equipment as agitating speed. Put all materials including mixing water in the drum before actuating the revolution counter for determining the number of revolutions of the drum.

When a truck mixer or truck agitator is used to transport concrete that has been completely mixed in a stationary mixer, perform mixing during transport at agitating speed.

Provide concrete, when discharged from truck mixers or truck agitators, of the consistency and workability required for the work. Control the rate of discharge of the plastic concrete from the mixer drum by the speed or rotation of the drum in the discharge direction with the discharge gate fully open. If additional mixing water is necessary to produce the slump necessary for proper placement, perform it only with permission, and rotate the truck mixer drum a minimum of 25 revolutions at mixing speed before discharge of any concrete. Additional mixing water will be allowed only if the maximum specified water content per cubic yard is not exceeded.

(D) Delivery

Use a ticket system for recording the transportation of batches from the proportioning plant to the site of the work. Use tickets furnished by the Engineer and fill it out in accordance with instructions issued by the Engineer. Issue the tickets to the truck operator at the proportioning plant for each load and have them signed by the plant inspector, which will signify that the concrete in the truck has been inspected prior to departure. Have each ticket show the time batching was completed and if transit mixed, the number of revolutions at mixing speed, if any, at the plant. Deliver the tickets to the inspector at the site of the work. Do not use loads which do not carry such tickets and loads which do not arrive in satisfactory condition within the time limits specified in the work.

SECTION 1005
GENERAL REQUIREMENTS FOR AGGREGATE

1005-1 GENERAL

Provide aggregates meeting the applicable requirements of this section except where otherwise required.

Obtain aggregates from sources participating in the Department's Aggregate Quality Control/Quality Assurance Program (Aggregate QC/QA program) as described in Article 1006. Obtain aggregates from pre-approved sources, or have the source approved prior to use. Approval of such sources is based not only on the quality of the aggregate, but also on satisfactory production facilities and procedures. A list of approved aggregate sources participating in the Department's Aggregate Quality Control/Quality Assurance Program in North Carolina and adjoining states is available from the Department's Laboratory in Raleigh. This list includes aggregates meeting Specification requirements but whose use is restricted due to history of unsatisfactory service performance. Use of aggregates is allowed in the work provided they have been properly stockpiled in units of

not less than 300 tons and tests of representative samples of these aggregates indicate satisfactory compliance with the Specifications and the source meets all the requirements of the Aggregate Quality Control/Quality Assurance Program.

Separate aggregate containing rock of more than 1 identifiable rock type or particles of visibly different degrees of weathering in amounts of 10 percent or more into each individual type. Aggregate is acceptable only if each type does not exceed the percentage of wear specified for a particular use.

Blended aggregates from different sources is allowed if all aggregates meet the Specifications for soundness or resistance to abrasion.

For construction of approved stockpiles of non-asphalt type bases refer to the *Construction Manual*.

1005-2 HANDLING AND STORING AGGREGATES

Handle and stockpile aggregates in such a manner to minimize segregation.

Provide sites for aggregate stockpiles that are cleared, grubbed, and cleaned with a firm, smooth, and well drained ground surface. Maintain a cover of at least 3" of aggregate over the ground surface to avoid the inclusion of soil or foreign material. Operate trucks or other equipment on a stockpile in an acceptable manner.

Space or separate with suitable walls or partitions stockpiles of different types or sizes of aggregates to prevent the mixing of the aggregates. Identify stockpiles with signs that can be read from a distance of at least 50 feet from the pile.

Do not allow the stockpile to become contaminated with foreign matter or degrade excessively. Failure of aggregate samples to meet all gradation requirements due to excessive degradation will be determined by sieve tests of samples taken from any portion of the stockpile and is cause for discontinuance of such stockpiling procedure.

1005-3 GRADATION

Grade all standard sizes of aggregate to meet the requirements of Table 1005-1 or Table 1005-2. Comparison of individual Producer Quality Control Samples and the corresponding Department Quality Assurance Sample shall meet the requirements of Table 1005-3 or Table 1005-4 as described in the *Aggregate QC/QA Program Manual.*

1005-4 TESTING

(A) General

Aggregates will be tested in accordance with the requirements of the Table shown below except where other test procedures are required by other articles covering a particular application.

TEST	TEST METHOD
Gradation	AASHTO T27 AND T11; AASHTO T88 As Modified* For Base Course and Stabilizer
Liquid Limit	AASHTO T89 As Modified
Plasticity Index	AASHTO T90
Resistance to Abrasion (Percentage of Wear)	AASHTO T96
Soundness	AASHTO T104 Using Sodium Sulfate

* Copies of modified test procedures are available from the Materials and Tests Unit

TABLE 1005-1
AGGREGATE GRADATION, COARSE AGGREGATE

STD. SIZE #	PERCENTAGE OF TOTAL BY WEIGHT OF PASSING																REMARKS
	2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#10	#16	#30	#40	#50	#80	#100	#200	
4	100	90-100	20-55	0-15		0-5										0-*0.6	Asphalt Plant Mix Pavement
467M	100	95-100		35-70		0-30	0-5									0-*0.6	Asphalt Plant Mix Pavement
5		100	90-100	20-55	0-10	0-5										0-*0.6	AST Mat coat, Sediment Control Stone
57		100	95-100		25-60		0-10	0-5								0-*0.6	Str. Conc., Shoulder Drain, Sediment Control Stone
57M		100	95-100		25-45		0-10	0-5								0-*0.6	P. C. Concrete Pavement
6M			100	90-100	20-55	0-20	0-8									*	AST
67			100	90-100		20-55	0-10	0-5								0-*0.6	Str. Conc., Asphalt Plant Mix Pavement.
78M				100	98-100	75-100	20-45	0-15								0-*0.6	Asphalt Plant Mix Pavement, AST Weep Hole Drains, Str. Concrete
14M						100	35-70	5-20		0-8						*	* AST
ABC		100	75-97		55-80		35-55		25-45			14-30				4-12**	Aggregate. Stabilization Aggregate/Base Course Asphalt Plant Mix Pavement
ABC(M)		100	75-100		45-79		20- 40		0-25							0-12**	Maintenance Stabilization

*When these sizes of aggregate are used for portland cement concrete, asphalt treatment, and asphalt plant mix, the requirements pertaining to material passing the No. 200 sieve are as follows:

(A) When tested during production, do not have the amount of material passing through the No. 200 sieve be more than 0.6% by weight.

(B) When tested in a stockpile at the quarry site, do not have the amount of material passing through the No. 200 sieve be more than 1.0% by weight and use material that consists mainly of rock dust produced through normal handling of the aggregate.

(C) When tested at the job site prior to use, the amount of material passing the No. 200 sieve shall:

  (1) Be not greater than 1.5% for coarse aggregate used in portland cement concrete or asphalt surface treatment.

  (2) Be not greater than 2.0% for coarse aggregate used in asphalt plant mix.

  (3) Consist essentially of rock dust produced through normal handling of the aggregate.

(D) If a stockpile at the job site is found to contain in excess of the specified amount of material passing the No. 200 sieve prior to use, the Engineer may approve its use provided:

  (1) For coarse aggregate used in portland cement concrete, the total percentage by weight passing the No. 200 sieve in the combined coarse and fine aggregate in the mix does not exceed 2.0%, and provided no increase in water-cement ratio is required by the use of this coarse aggregate.

  (2) For coarse aggregate used in asphalt plant mix, the total percentage by weight of minus No. 200 material in the plant mix being produced, as determined by the extraction test, can be maintained within the limits allowed by the job mix formula.

** In addition to the gradation requirements, the material passing the No. 40 sieve shall not have a liquid limit in excess of 30 nor a plasticity index in excess of 6. For size ABC coarse aggregate used in asphalt plant mix, when tested during production, in a stockpile at the quarry site, or at the job site prior to use, the amount of material passing the No. 200 sieve shall be from 0.0% to 12.0% by weight and the gradation requirements for material passing the No. 10 sieve (soil mortar) which are shown in Section 1010 for aggregate base course will not apply. For size ABC coarse aggregate not used in asphalt plant mix, the gradation requirements for material passing the No. 10 sieve (soil mortar) will be as shown in Section 1010, 40-84% passing the No. 40 sieve and 11-35% passing the No. 200 sieve.

TABLE 1005-2
AGGREGATE GRADATION FINE AGGREGATE

STD. SIZE #	PERCENTAGE OF TOTAL BY WEIGHT PASSING											REMARKS
	3/8"	#4	#8	#10	#16	#30	#40	#50	#80	#100	#200	
1S	100	90-100			40-85			0-20			0-3	Blotting Sand, Asphalt Retreatment
2S	100	95-100	80-100		45-95	25-75		5-30		0 .010	0-3	Concrete, Sub-surface Drainage, Blotting Sand
2MS		95-100	80-100		45-95	25-75		5-35		0.-.020	0-*8	Concrete
4S		100	95-100					15-45		0-10	0-5	Mortar

* For Manufactured Fine Aggregate used In portland cement concrete

When tested during production the amount of material passing the No. 200 sieve shall not be greater than 8%. When tested at the job site prior to use, the amount of material passing the No. 200 sieve shall not be greater than 10% and shall consist of the dust of fracture, and be essentially free from clay or shale. The minimum percent shown for material passing the No. 50 and No. 100 sieves may be reduced to 5 and 0, respectively, if the aggregate is to be used in air-entrained concrete containing more than 400 pounds of cementitious material per cubic yard or in non-air entrained concrete containing more than 500 pounds of cementitious material per cubic yard or as subdrain fine aggregate.

Table 1005-3
Tolerances for Comparisons of Coarse Aggregate QC/QA Gradations

Sieve Sizes	ABC	#4	#467M	#5	#57 #57M	#6	#14M	#67	#78M
2"									
1 1/2"		+/- 2	+/- 2		+/- 2				
1"	+/- 4	+/- 4		+/- 2	+/- 3			+/- 2	
3/4"		+/- 4	+/- 5	+/- 5		+/- 3		+/- 3	+/- 2
1/2"	+/- 5			+/- 2	+/- 5	+/- 4			+/- 3
3/8"		+/- 2	+/- 3	+/- 2		+/- 4	+/- 3	+/- 5	+/- 3
#4	+/- 6		+/- 2		+/- 3	+/- 2	+/- 5	+/- 3	+/- 5
#8					+/- 3		+/- 5	+/- 3	+/- 3
#10	+/- 5								
#40	+/- 5								
#80									
#200	+/- 3	+/- 0.5	+/- 0.5	+/- 0.5	+/- 0.5	+/- 0.5	+/- 0.5	+/- 0.5	+/- 0.5
Soil Mortar									
#40	+/- 6								
#200	+/- 5								
LL	+/- 4								

Table 1005-4
Tolerances for Comparisons of Fine Aggregate QC/QA Gradations

Sieve Sizes	Dry Screenings	Washed Screenings	Asphalt Sand	1S	2S	2MS	4S
1/2"							
3/8"							
#4	+/- 2	+/- 2	+/- 2				
#8	+/- 6	+/- 6	+/- 6	+/- 1	+/- 1	+/- 1	+/- 2
#10							
#16				+/- 3	+/- 3	+/- 3	+/- 3
#30				+/- 3	+/- 3	+/- 3	+/- 3
#40	+/- 6	+/- 6	+/- 6				
#50				+/- 2	+/- 2	+/- 2	+/- 3
#80	+/-4	+/-4	+/-4				
#100				+/- 1	+/- 1	+/- 1	+/- 2
#200	+/- 2	+/- 2	+/- 2	+/- 1	+/- 1	+/- 1	+/- 1

SECTION 1006
AGGREGATE QUALITY CONTROL/QUALITY ASSURANCE

1006-1 GENERAL DESCRIPTION

The Aggregate Quality Control/Quality Assurance Program is designed to give aggregate producers more responsibility for controlling the quality of material they produce and to utilize the quality control information they provide in the acceptance process by the Department. It requires aggregate producers to perform quality control sampling, testing and record keeping on aggregates they ship for use by the Department. Also, it requires the Department to perform quality assurance sampling, testing and record keeping confirming the performance of the producers' control plan. The program is described in the *Aggregate Quality Control/Quality Assurance Program Manual*. The program has two levels.

Section I of the program is designed for Aggregate Producers providing Clean Coarse or Fine Aggregates for use on or in products such as asphalt, concrete, block, etc., that are utilized on the Department's right of way. Asphalt sand that is produced by and utilized by the same asphalt producer shall be tested according to the requirements of the *Hot Mix Asphalt Quality Management System Manual*.

Section II of this program is designed for Aggregate Producers providing any type of Aggregate Base, including Cement Treated, material that is utilized on any type of the Department's Maintenance or Contract projects whether purchased by a Contractor or sold directly to the Department.

The types of samples and the lot sizes required by both levels are described in detail in the *Aggregate Quality Control/Quality Assurance Program Manual* and in other sections of the *Specifications*.

It is the intent of the program that acceptance or rejection of material be based on the total program. Therefore, a comparison of the Quality Control, Quality Assurance, and

other sample data may be used by the Department for acceptance or rejection of a lot of material.

Participation in this program does not relieve the producer of the responsibility of complying with all requirements of the Department's Specifications.

1006-2 PROGRAM REQUIREMENTS

(A) Basic Requirements

There are three basic requirements for approval:

(1) The plant shall have an approved in-house quality control plan.

(2) --- The plant shall have a certified laboratory or have written approval to utilize a certified laboratory at another plant.

(3) --- The plant shall have a certified quality control technician.

(B) Quality Control Plan

The Producer shall prepare a written quality control plan. The plan may be generic, but shall be site specific. The plan shall indicate in detail how the Producer proposes to control the equipment, materials, and production methods to insure that the specified products are obtained. The plan shall list the personnel responsible for production and quality control at the site and include information on how to contact each person. The following specific information shall also be included in the plan:

(1) Identification of the physical location of the source, to include a description of the property site and reference to the nearest identifiable points such as highways and towns.

(2) The type of sign used to identify each stockpile or bin identifying it as intended for Department usage.

(3) A loading and shipping control plan which includes a description of the methods by which the products are to be loaded and shipped for use by the Department, including safeguards against loading improper aggregate, contamination, degradation, and segregation of the aggregate. The plan shall also include methods of insuring that all products are accurately identified and that all shipping units are clean.

(4) A plan for dealing with quality control sample failures. This plan shall include how the Producer plans to initiate an immediate investigation and how the Producer will implement corrective action to remedy the cause of the problem.

(C) Certified Laboratory

The Program requires all tests to be conducted at laboratories certified by the Department. It is expected that each source, including distribution yards, will establish and maintain its own laboratory for the performance of quality control testing, but the Department will consider a producer's request to utilize a certified

laboratory at one of their other sources in the same general vicinity. The Producer shall make this request in writing and have written Department approval before testing aggregates off site. The equipment required for a certified laboratory is listed in the *Aggregate QC/QA Program Manual*. Records on instrument calibration and maintenance and sample collection and analysis shall be maintained at the laboratory. The Department may require a demonstration of the equipment.

(D) Quality Control Technician

All samples shall be taken and tested by quality control technicians certified by the Department. The Producer shall designate and identify the quality control technicians responsible at each plant. It is imperative that Department sampling and testing procedures be followed and that Department approved equipment be used in order to reduce the number of possible causes of differences between the producer's quality control results and the Department's quality assurance results.

(E) Plant Approval Process

The approval process requires the Producer to write the State Materials Engineer at NCDOT Materials and Tests Unit, 1801 Blue Ridge Road, Raleigh, NC 27607, requesting the plant be considered for acceptance into the program. The letter shall identify the specific products that are to be produced. Two copies of the Producer's written quality control plan shall be submitted with the request for approval.

A source shall be on the Department Approved Source List before it will be considered for approval for the QC/QA Program.

The Department will review the Producer's written quality control plan and if it is approved, an on-site inspection will be scheduled. This on-site inspection will verify that the Producer's quality control plan has been implemented and is being followed and that at least one certified quality control technician is on site and will be present when material is being shipped under this program. The laboratory will be inspected and certified if it meets the requirements and has not already been certified. If either the Producer's quality control plan or laboratory do not meet Department requirements, the Producer will be informed of the deficiencies in writing. Once the deficiencies have been addressed, the Producer may again request approval in writing to the State Materials Engineer.

(F) Certification for Participation in the Aggregate QC/QA Program

If the Department has approved the Producer's written quality control plan and the on-site inspection confirms that the initial program requirements have been met, the Department will certify the plant for participation in the program. At the end of the year, and each subsequent year after receipt of the Plant Ownership Update, the Department will conduct another on-site inspection and if all requirements are continuing to be met, the plant will be recertified for participation in the program for another year. Random inspections may be conducted at any time by the Department to verify compliance with the program requirements.

A copy of the Plant Ownership Update Form shall be submitted by October 31st of each year.

SECTION 1008
AGGREGATE BASE COURSE FOR STABILIZATION

1008-1 AGGREGATE STABILIZATION

(A) General

Aggregates consist of crushed stone, crushed or uncrushed gravel, or other similar material having hard, strong, durable particles free of adherent coatings.

The Contractor may, at his option, furnish aggregates directly to the road or from a stockpile.

Supply aggregates from approved sources participating in the Department's Aggregate Quality Control/Quality Assurance Program (Aggregate QC/QA Program) in accordance with the requirements of Sections 1005 and 1006. Sources will not be approved unless the material has satisfactory soundness and satisfactory resistance to abrasion. Satisfactory soundness will be considered to be a loss in weight of not greater than 15 percent when subject to 5 alternations of the soundness test. Satisfactory resistance to abrasion will be considered to be a percentage of wear of not greater than 55 percent.

(B) Sampling and Acceptance

Sampling and acceptance for the determination of gradation, liquid limit, and plasticity index will be performed as provided in Subarticle 1008-1(D).

(C) Testing

Quality Control Samples will be tested at a Department Certified Laboratory according to the *Aggregate QC/QA Program Manual*. Assurance Samples will be tested at a Department laboratory.

(D) Department Roadway Assurance Sampling

For sampling and acceptance purposes, a lot will be 5,000 tons or fraction thereof. For each lot of aggregate delivered to the project, 2 samples will be taken at random intervals. The first sample will be taken from the first 2,500 tons or first half of the lot; the second sample will be taken from the second 2,500 tons or second half of the lot. The gradation test results of these samples will be averaged and the average will be used to determine the acceptability of the lot.

It is intended that the gradation of aggregates be in the middle of the range shown in Column B of Table 1008-1. If, however, the average test results for a lot are within the limits shown in Column B of Table 1008-1, the gradation of the lot will be considered as acceptable.

TABLE 1008-1
AGGREGATE BASE COURSE FOR STABILIZATION
GRADATION ACCEPTANCE CRITERIA

Column A Sieve Size	Column B % Passing
l 1/2"	100
1"	72-100
1/2"	51-83
No. 4	35-60
No. 10	20-50
No. 40	10-34
No. 200	3-13
Material Passing No. 40 Sieve	
L. L.	0-30
P. I.	0-6

When the average test results for a lot exceeds any of the limits shown in Column B of Table 1008-1, the lot will be rejected. The rejected lot will be considered for acceptance only after corrective material has been furnished, placed, and mixed with the in place aggregate to an acceptable gradation.

The liquid limit and plasticity index requirements for the material passing the No. 40 sieve shown in Table 1008-1 is for each individual sample. The results will not be averaged and if any individual test result indicates a value exceeding these requirements is cause for rejection of the entire lot.

SECTION 1010
AGGREGATE FOR NON-ASPHALT FLEXIBLE TYPE BASES

1010-1 AGGREGATE BASE COURSE--GENERAL

(A) General Requirements

Aggregate base course material consists of crushed stone, crushed or uncrushed gravel, or other similar material having hard, strong, durable particles free of adherent coatings.

Produce aggregate base course material in accordance with the requirements for aggregate unless otherwise specified in the Specifications.

Provide aggregates from approved sources participating in the Department's Aggregate Quality Control/Quality Assurance Program (Aggregate QC/QA Program) in accordance with the requirements of Section 1005 and Section 1006. Sources will not be approved unless the material has satisfactory soundness and resistance to abrasion. Satisfactory soundness will be considered to be a weighted average loss of

not greater than 15 percent when subjected to 5 alternations of the soundness test. Satisfactory resistance to abrasion will be considered to be a percentage of wear of not greater than 55 percent.

(B) Testing

Quality Control Samples will be tested at a Department Certified Laboratory according to the Aggregate QC/QA Program. Assurance Samples will be tested at a Department laboratory.

TABLE 1010-1

AGGREGATE BASE COURSE
GRADATION ACCEPTANCE RANGES

Column A	Column B % Passing	Column C % Passing	Column D Range	Column E
1 1/2"	100	98-100	3	1
1"	75-97	72-100	15	1
1/2"	55-80	51-83	20	1
# 4	35-55	35-60	18	3
# 10	25-45	20-50	18	2
# 40	14-30	10-34	14	3
# 200	4-12	3-13	7	5
Material Passing No. 10 Sieve (Soil Mortar)				
# 40	40-84	36-86	35	2
# 200	11-35	10-36	20	2
Material Passing No. 40 Sieve				
L. L.	0-30	0-30	–	–
P. I.	0-6	0-6	–	–

1010-2 AGGREGATE BASE COURSE

Aggregate Base Course is aggregate upon which no restrictions are placed on production or stockpiling except as provided for in Sections 1005 and 1006.

(A) Producer's Quality Control Sampling

Plant Sampling The lot size for ABC will be 2,000 tons of material, or a fraction thereof, shipped. The certified plant technician is to obtain a pair of Quality Control (QC) samples, labeled A and B, each weighing a minimum of 70 lbs. from each lot of ABC. Each sample is to be split into two halves, using procedures outlined in Exhibit C of the *Aggregate QC/QA Program Manual*. Each half is to be clearly identified.

The other half of the samples will be retained and made available to the Department.

These retained samples will serve as the pool from which random Quality Assurance samples will be obtained by the Department. The Department's Quality Assurance testing is discussed in the *Aggregate QC/QA Program Manual*.

Price Reductions and Corrections If the Quality Control samples do not meet the gradation requirements of Column B, or the range requirements of Column D, or the LL and PI requirements of Column B of Table 1010-1 of the Specifications, the procedures are as follows

Gradation For the lot to be acceptable, the average test results shall meet the gradation requirements shown in Column B of Table 1010-1. When the average test result exceeds the gradation limits given in Column B but falls within the limits given in Column C, the lot will be rejected and shall be removed and replaced by the Contractor, or at the option of the Contractor, the lot may be left in place and the material will be considered as being reasonably acceptable in accordance with the requirements of Article 105-3, and an adjustment in contract unit price will be made as follows:

The number of points shown in Column E of Table 1010-1 will be assigned to the lot involved on an accumulative basis for each percent that the base material is outside the gradation range shown in Column B. Price adjustments will be made by reducing the contract unit price by 2 percent for each point assigned. The unit price adjustment for average gradation will be in addition to any price adjustment determined necessary for nonuniform base material (range).

When the test results for a lot exceed the gradation shown in Column C of Table 1010-1, the lot will be rejected and shall be removed and replaced by the Contractor at no cost to the Department or at the option of the Contractor, the lot may be corrected as described below.

Range When the test results for the 2 samples used to determine the average test result for acceptance exceed the range established by Column D of Table 1010-1, the lot, at the option of the Contractor, may be corrected or judged to be nonuniform and acceptance will be made in accordance with Article 105-3 and an adjustment in contract unit price will be made as follows:

The number of points shown in Column E of Table 1010-1 will be assigned to the lot involved on an accumulative basis for each percent that the range between the test results of the 2 samples exceeds those values given in Column D. Price adjustments will be made by reducing the contract unit price by 2 percent for each point assigned. The unit price adjustment for nonuniform base material will be in addition to any price adjustment determined necessary for average gradation (gradation).

LL/PI In addition to the gradation acceptance requirements listed in Table 1010-1, the material passing the No. 40 sieve shall not have a Liquid Limit in excess of 30 or a plasticity index in excess of 6. If any individual test result indicates values exceeding these, the lot will be rejected and shall be removed and replaced by the Contractor.

Total Points Any lot having an assigned accumulative gradation and range total of more than 25 points will be rejected and shall be removed and replaced by the

Contractor at no cost to the Department or at the option of the Contractor, the lot may be corrected.

Roadway Correction When the Contractor chooses the option to correct the sublot, the Contractor will take 2 random Roadway Quality Control Samples from within the corrected sublot. When the average test results of the Contractor's two Roadway Samples fall within the gradation limits as shown in Column B of Table 1010-1, the range limits as shown in Column D of Table 1010-1, and the LL and PI meet the requirements of Subarticle 1010-(4)(B)(3), the corrected sublot will be acceptable for Quality Assurance Sampling by the Department.

The Contractor shall correct a QC lot on the roadway only once.

(B) Department Quality Assurance Sampling

Plant Sampling All Quality Assurance samples are to be taken on a random basis from the available split Quality Control (QC) samples. ABC samples are to be taken at a minimum rate of one QA sample for each 5,000 tons of material shipped or at least one each week, whichever occurs more often.

QC/QA Comparison If the results of the Quality Assurance sample are not in agreement with the corresponding Quality Control sample, i.e. outside the limits of Table 1005-3, an investigation is to be made to determine the source of the difference. The investigation will include a review of the sampling and testing procedures and the testing equipment.

If the cause of the difference can be determined, it is to be noted on the Plant Quality Assurance Form. If the cause is determined to be improper sampling or testing procedures, the appropriate certified technician will be notified. If the problem continues, the technician's certification may be revoked. If the cause is determined to be in the Producer's testing equipment or handling of the material, the Producer is to take corrective action. If this problem continues, the Producer's approval to provide material to the Department may be revoked. If the cause is determined to be in the Department's' testing equipment, the Department will take corrective action.

If the investigation does not reveal the cause of the disparity, another QC/QA comparison will be made on the next sample taken in the presence of the Department. If the comparison is within the limits of Table 1005-3, the shipment of material may continue. If, however, the comparison is not within the limits of Table 1005-3, the shipment of material is to cease and further investigation will be performed.

(C) Department Roadway Assurance Sampling

For sampling and acceptance purposes, a lot will be 5,000 tons or a fraction thereof.

For each lot of aggregate placed on the road, 2 samples will be taken at random locations on the road prior to compaction. The first sample will be taken from the first 2,500 tons or first half of the lot; the second sample will be taken from the second 2,500 tons or second half of the lot. The gradation test results of these samples will be averaged. The LL and PI results will not be averaged. The LL, PI,

range, and average gradation results of these samples will be used to determine the acceptability of the lot.

LL/PI The material passing the No. 40 sieve shall not have a Liquid Limit in excess of 30 or a Plasticity Index in excess of 6. If any individual test result indicates values exceeding these, the lot will be rejected.

Range When the test results for the 2 samples used to determine the average test result for acceptance exceed the range established by Column D of Table 1010-1, the lot, at the option of the Contractor, may be corrected or judged to be nonuniform and acceptance will be made in accordance with Article 105-3 and an adjustment in contract unit price will be made as follows

The number of points shown in Column E of Table 1010-1 will be assigned to the lot involved on an accumulative basis for each percent that the range between the test results of the 2 samples exceeds those values given in Column D. Price adjustments will be made by reducing the contract unit price by 2 percent for each point assigned. Any lot having an assigned accumulative range total of more than 25 points will be rejected.

Gradation For the lot to be acceptable, the average test results shall meet the gradation requirements shown in Column C of Table 1010-1. When the average gradation test result falls outside the limits of Column C of Table 1010-1, the lot will be rejected.

Check Samples For lots that are rejected, the following steps are to be taken:

(1) Perform additional sampling of the 5000 tons of material in order to isolate the unacceptable material. The procedure for this additional sampling consists of dividing the 5000 tons of material into two 2500 ton sublots and taking 2 samples at random locations from each of these two sublots. The results of the 2 samples will be used to determine the acceptance of each of the sublots.

(2) When the test results for a sublot are within the limits above for Range, LL/PI, and Average Gradation, the sublot will be considered acceptable.

(3) When the test results for a sublot exceed any of the limits above for Range, LL/PI, and Average Gradation, and the sublot cannot be corrected by the addition of aggregate or when the average gradation or range of a corrected sublot exceeds any of the limits of Table 1010-1, Column B or D, or the LL or PI of either sample exceed the limits of Table 1010-1 Column B, the sublot will be rejected and shall be removed and replaced at no additional cost to the Department unless otherwise approved by the Engineer.

(4) When the test results for a sublot exceed any of the limits shown in 3 above and the test results indicate the material can be corrected by the addition of aggregate, the Engineer may allow the material to be corrected provided there is no additional cost to the Department for furnishing, adding, remixing, reshaping, and recompacting of the added material. The method of correcting

the sublot shall be approved both by the Area Roadway Engineer and the Soils Engineer.

(5) Two samples will be randomly taken from the corrected sublot. When the average gradation or range of a corrected sublot exceeds any of the limits of Table 1010-1, Column B or D, or the LL or PI of either sample exceed the limits of Table 1010-1 Column B, the material will be removed and replaced at no additional cost to the Department in accordance with the requirements of Article 520-6.

1010-3 SOIL TYPE BASE COURSE.

Soil type base course consists of one or more natural materials proportioned and blended on the road, and will be Type A, B, or C. Use the type specified in the Specifications.

Provide soil type base course free from vegetative matter and lumps or balls of clay meeting the requirements of Table 1010-3 for the applicable type.

Samples will be taken in accordance with Article 530-8.

TABLE 1010-3
ACCEPTANCE CRITERIA FOR
SOIL TYPE BASE COURSE

Sieve Size	Type A	Type B	Type C
	% Passing	% Passing	% Passing
2"	--	100%	--
1"	100%	70-100%	100%
1/2"	--	55-100%	--
No. 4	--	35-80%	--
No. 10	65-100%	25-65%	65-100%
No. 40	--	15-45%*	--
No. 200	--	5-25%*	--
Material Passing No. 10 Sieve (Soil Mortar)			
No. 40	40-75%	--	40-95%
No. 200	12-35%	--	12-35%
Material Passing No. 40 Sieve			
L. L.	0-25	0-25	0-25
P. I.	0-6	0-6	0-6

* The fraction passing the No. 200 sieve shall be less than 2/3 the fraction passing the No. 40 sieve.

1010-4 AGGREGATE FOR PLANT MIXED CEMENT TREATED BASE COURSE

(A) General

Aggregate for plant mixed cement treated base course is aggregate from an approved source participating in the Department's Aggregate Quality Control/Quality Assurance Program (Aggregate QC/QA Program) as described in Section 1006 which has been tested and approved in accordance with the requirements of this article and the applicable requirements of Article 1010-1, except as may be modified by this article. Sources of aggregate will not be approved unless the material has a percentage of wear of not greater than 65 percent.

Provide aggregates meeting the gradation requirements of Table 1010-4 for a sampling unit or lot as defined by Subarticle 1010-4(B).

(B) Quarry production

(1) Producer's Quality Control Sampling

Plant Sampling The lot size will be 2,000 tons of material, or a fraction thereof, shipped. The certified plant technician is to obtain a pair of Quality Control (QC) samples, labeled A and B, each weighing a minimum of 70 lbs. from each lot. Each sample is to be split into two halves, using procedures outlined in Exhibit C or the *Aggregate QC/QA Program Manual*. Each half is to be clearly identified.

The other half of the samples will be retained and made available to the Department. These retained samples will serve as the pool from which random Quality Assurance samples will be obtained by the Department. The Department's Quality Assurance testing is discussed in the *Aggregate QC/QA Program Manual*.

Rejections and Corrections If the Quality Control samples do not meet the gradation requirements of Column B, or the range requirements of Column D, or the LL and PI requirements of Column B of Table 1010-4 of the Specifications, the procedures are as follows:

When the test results for a lot exceed the gradation shown in Column B of Table 1010-4, the lot will be rejected and shall be removed and replaced by the Contractor at no cost to the Department or at the option of the Contractor, the lot may be corrected as described below.

Range When the test results for the 2 samples used to determine the average test result for acceptance exceed the range established by Column C of Table 1010-4, the lot, at the option of the Contractor, may be corrected or judged to be nonuniform and acceptance will be made in accordance with Article 105-3 and an adjustment in contract unit price will be made as follows:

The number of points shown in Column D of Table 1010-4 will be assigned to the lot involved on an accumulative basis for each percent that

the range between the test results of the 2 samples exceeds those values given in Column C. Price adjustments will be made by reducing the contract unit price by 2 percent for each point assigned. The unit price adjustment for nonuniform material will be in addition to any price adjustment determined necessary for average gradation.

LL/PI In addition to the gradation acceptance requirements listed in Table 1010-4, the material passing the No. 40 sieve shall not have a Liquid Limit in excess of 30 or a plasticity index in excess of 4. If any individual test result indicates values exceeding these, the lot will be rejected and shall be removed and replaced by the Contractor.

Total Points Any lot having an assigned accumulative gradation and range total of more than 25 points will be rejected and shall be removed and replaced by the Contractor at no cost to the Department or at the option of the Contractor, the lot may be corrected.

Roadway Correction When the Contractor chooses the option to correct the sublot, the Contractor will take 2 random Roadway Quality Control Samples from within the corrected sublot. When the average test results of the Contractor's two Roadway Samples fall within the gradation limits as shown in Column B of Table 1010-4, the range limits as shown in Column D of Table 1010-4, and the LL and PI meet the requirements of Column B of Table 1010-4, the corrected sublot will be acceptable for Quality Assurance Sampling by the Department.

The Contractor is only allowed to correct a QC lot on the roadway once.

(2) Department Quality Assurance Sampling

Plant Sampling Take all Quality Assurance samples on a random basis from the available split Quality Control (QC) samples. Take them at a minimum rate of one QA sample for each 5,000 tons of material shipped or at least one each week, whichever occurs more often.

QC/QA Comparison - If the results of the Quality Assurance sample are not in agreement with the corresponding Quality Control sample, i.e. outside the limits of Table 1005-3, an investigation is to be made to determine the source of the difference. The investigation will include a review of the sampling and testing procedures and the testing equipment.

If the cause of the difference can be determined, it is to be noted on the Plant Quality Assurance Form. If the cause is determined to be improper sampling or testing procedures, the appropriate certified technician will be notified. If the problem continues, the technician's certification may be revoked. If the cause is determined to be in the Producer's testing equipment or handling of the material the Producer is to take corrective action. If this problem continues, the Producer's approval to provide material to Department may be

revoked. If the cause is determined to be in the Department's testing equipment, the Department will take corrective action.

If the investigation does not reveal the cause of the disparity, another QC/QA comparison will be made on the next sample taken in the presence of the Department. If the comparison is within the limits of Table 1005-3, the shipment of material may continue. If, however, the comparison is not within the limits of Table 1005-3, the shipment of material is to cease and further investigation will be performed.

(3) Department Roadway Assurance Sampling

For sampling and acceptance purposes, a lot will be 5,000 tons or a fraction thereof.

For each lot of aggregate placed on the road, 2 samples will be taken at random from the pugmill belt or roadway prior to the cement being added. The first sample will be taken from the first 2,500 tons or first half of the lot; the second sample will be taken from the second 2,500 tons or second half of the lot. The gradation test results of these samples will be averaged. The LL and PI results will not be averaged. The LL, PI, range, and average gradation results of these samples will be used to determine the acceptability of the lot.

LL/PI The material passing the No. 40 sieve shall not have a Liquid Limit in excess of 30 or a Plasticity Index in excess of 4. If any individual test result indicates values exceeding these, the lot will be rejected.

Range When the test results for the 2 samples used to determine the average gradation test result for acceptance exceed the range established by Column C of Table 1010-4, the lot will be judged to be nonuniform and an adjustment in contract unit price will be made as follows:

The number of points shown in Column D of Table 1010-4 will be assigned to the lot involved on an accumulative basis for each percent that the range between the test results of the 2 samples exceeds those values given in Column C. Price adjustments will be made by reducing the contract unit price by 2 percent for each point assigned. Any lot having an assigned accumulative range total of more than 25 points will be rejected.

Check Samples of the material may be taken by the Engineer in accordance with the procedures listed below if cement has not yet been added.

Gradation For the lot to be acceptable, the average test results shall meet the gradation requirements shown in Column B of Table 1010-4. When the average gradation test result falls outside the limits of Column B of Table 1010-4, the lot will be rejected.

Check Samples For lots that are rejected, the following steps are to be taken if cement has not yet been added to the material:

(a) Perform additional sampling of the 5000 tons of material in order to isolate the unacceptable material. The procedure for this additional sampling consists of dividing the 5000 tons of material into two 2500 ton sublots and taking 2 samples at random locations from each of these two sublots. The results of the 2 samples will used to determine the acceptance of each of the sublots.

(b) When the test results for a sublot are within the limits above for Range, LL/PI, and Average Gradation, the sublot will be considered acceptable.

(c) When the test results for a sublot exceed any of the limits above for Range, LL/PI, and Average Gradation, and the sublot cannot be corrected by the addition of aggregate or when the average gradation or range of a corrected sublot exceeds any of the limits of Table 1010-4, Column B, or the LL or PI of either sample exceed the limits of Table 1010-4 Column B, the sublot will be rejected and shall be removed and replaced at no additional cost to the Department unless otherwise approved by the Engineer.

(d) When the test results for a sublot exceed any of the limits shown above and the test results indicate the material can be corrected by the addition of aggregate, the Engineer may allow the material to be corrected provided there is no additional cost to the Department for furnishing, adding, remixing, reshaping, and recompacting of the added material. The method of correcting the sublot shall be approved both by the Area Roadway Engineer and the Soils Engineer.

(e) Two samples will be randomly taken from the corrected sublot. When the average gradation or range of a corrected sublot exceeds any of the limits of Table 1010-4, Column B, or the LL or PI of either sample exceed the limits of Table 1010-4 Column B, the material will be removed and replaced at no additional cost to the Department in accordance with the requirements of Subarticle 520-6(B).

TABLE 1010-4
ACCEPTANCE CRITERIA FOR
AGGREGATE FOR PORTLAND CEMENT TREATED BASE COURSE

Column A Sieve	Column B	Column C Range	Column D Points
1 1/2"	100%	3	1
1"	80-100%	15	1
1/2"	58-83%	20	1
No. 4	38-60%	18	3
No. 10	28-50%	18	2
No. 40	15-33%	14	3
No. 200	6-13%	7	5

Material Passing No. 10 Sieve (Soil Mortar)			
No. 40	40-85%	35	2
No. 200	12-35%	20	2
Material Passing No. 40 Sieve			
L. L.	0-30	-	
P. I.	0-4	-	

SECTION 1012
AGGREGATE FOR ASPHALT PAVEMENTS AND SURFACE TREATMENTS

1012-1 AGGREGATES FOR ASPHALT PLANT MIXES

(A) General

Formulate the asphalt plant mix with coarse and fine aggregate that meets the requirements of Section 1005, except as noted herein. Size, uniformly grade, and combine the several aggregate fractions in such proportions that the resulting mixture meets the grading and physical requirements of these Specifications for the specified mix type. Materials that will not produce a mixture within the design criteria required by these Specifications will be rejected, unless otherwise approved.

The consensus property criteria in Table 1012-1 apply to the coarse aggregate or fine aggregate blend. Source property criteria apply to individual aggregate sources.

For all surface course mixes, except OGAFC, that are the top or final layer, limit the amount of coarse aggregate or fine aggregate produced from crystalline limestone, crystalline-dolomitic limestone, or marble to a maximum of 50% of the total amount of coarse aggregate or fine aggregate in the asphalt mixture. Do not use aggregates produced from crystalline limestone, crystalline-dolomitic limestone, or marble in the production of open-graded asphalt friction course.

(B) Coarse Aggregate

(1) General

Use coarse aggregate consisting of crushed stone, crushed gravel, a mixture of uncrushed gravel with either crushed stone or crushed gravel, or other inert material having similar characteristics. Provide coarse aggregate composed of clean, tough, durable fragments free from an excess of flat or elongated pieces, and free of organic matter and deleterious substances.

Use coarse aggregate from sources participating in the Department's Aggregate Quality Control/Quality Assurance (QC/QA) Program as described in Section 1006. A list of sources participating in the Department's QC/QA Program in North Carolina and adjoining states is available from the Department's Materials and Tests Unit in Raleigh.

(2) Gradation

Use standard size coarse aggregate meeting the requirements of Table 1005-1 and these Specifications unless otherwise approved.

(3) Coarse Aggregate Angularity (Fractured Faces)

Use coarse aggregate meeting the requirements of Table 1012-1 for course aggregate angularity (fractured faces) when tested in accordance with ASTM D 5821.

(4) Flat and Elongated Pieces

Use coarse aggregate meeting the requirements of Table 1012-1 for flat and elongated pieces when tested in accordance with ASTM D 4791 (Section 8.4) on the No. 4 sieve and larger with a 5:1 aspect ratio (maximum to minimum) for all pavement types, except there is no requirement for, Types S4.75A, SF9.5A and S 9.5B.

(5) Soundness

The maximum weighted average soundness loss of individual coarse aggregate sources when subjected to 5 cycles using sodium sulfate when tested in accordance with AASHTO T 104 is 15%.

TABLE 1012-1
AGGREGATE CONSENSUS PROPERTIES [a]

Mix Type	Course Aggregate Angularity[b]	Fine Aggregate Angularity % Minimum	Sand Equivalent % Minimum	Flat &Elongated 5 : 1 Ratio % Maximum
	ASTM D 5821	AASHTO T304 Method A	AASHTO T 176	ASTM D 4791 Section 8.4
S.4.75		40	40	
SF9.5A S 9.5 , B				
S 12.5 B	75 / -	40	40	10[c]
I 19.0 B B 25.0 B				
S 9.5 C				
S 12.5 C	95 / 90	45	45	10
I 19.0 C B 25.0 C B 37.5 C				
S 12.5 D	100 / 100	45	50	10
I 19.0 D				
OGAFC	100/100	NA	NA	NA

Notes [a]Requirements apply to the coarse aggregate blend and/or fine aggregate blend

[b] 95/90 denotes that 95% of the coarse aggregate has one fractured face and 90% has two or more fractured faces.

[c] Does not apply to Mix Types S 9.5A and S 9.5B.

(6) Toughness (Resistance to Abrasion)

The maximum allowable percentage of loss of each individual coarse aggregate source for all plant mix types except open-graded asphalt friction

course, when tested in accordance with AASHTO T 96 is 55%. The maximum percentage loss for aggregate used in OGAFC is 45%.

(7) Deleterious Materials

The maximum allowable percentage by weight of clay lumps and friable particles in individual aggregate sources when tested in accordance with AASHTO T 112 is 0.3%.

(C) Fine Aggregate

(1) General

Use fine aggregate that is consistently graded from coarse to fine and consists of natural sand, stone screenings, or a blend of natural sand and stone screenings. Use aggregate composed of rough surfaced and angular grains of quartz or other hard durable rock.

Use fine aggregate from sources participating in the Department's Aggregate Quality Control/Quality Assurance (QC/QA) Program as described in Section 1006 unless the fine aggregate is produced at a pit owned by the same owner as the asphalt plant where the material is used. A list of sources participating in the Department's QC/QA Program in North Carolina and adjoining states is available from the Department's Materials and Tests Unit in Raleigh.

Furnish sand from sources that have been approved. Do not use sources that have been contaminated by industrial waste. A sufficient number of samples of fine aggregate, but in no case less than three, will be taken to indicate any variation within any stockpile or source of supply.

Do not use fine aggregate containing sticks, roots, trash, visible lumps of clay, or other unsatisfactory material unless all undesirable material is removed to the satisfaction of the Engineer before the aggregate is used in the asphalt mixture.

Use natural sand that is non-plastic when tested in accordance with AASHTO T 90.

Natural sand that contains grains of questionable hardness will be subjected to 5 cycles of the soundness test. The weighted average loss shall be not more than 15 percent. The soundness test will be performed prior to establishing the mix design.

Produce stone screenings from stone that has a maximum percentage of wear of 55 percent when tested in accordance with AASHTO T 96 using test grading A.

(2) Gradation

Use stone screenings that are consistently graded with not more than 20 percent by weight passing the No. 200 sieve when tested by dry sieving in accordance with AASHTO T 27. Use natural sand that is consistently graded.

(3) Clay Content (Sand Equivalent)

Use a fine aggregate blend that has a minimum sand equivalent percentage as indicated in Table 1012-1 when tested in accordance with AASHTO T 176.

(4) Soundness

The maximum weighted average soundness loss of individual fine aggregate sources when subjected to 5 cycles using sodium sulfate when tested in accordance with AASHTO T 104 is 15%.

(5) Deleterious Materials

The maximum percentage by weight of clay lumps and friable particles in individual fine aggregate sources when tested in accordance with AASHTO T 112 is 0.3 %.

(6) Fine Aggregate Angularity

Use a fine aggregate blend that has a minimum fine aggregate angularity as indicated in Table 1012-1 when tested in accordance with AASHTO T 304 Method A.

(D) Mineral Filler

Use mineral filler consisting of limestone dust, dolomite dust, portland cement, or other inert mineral matter that conforms to the requirements of AASHTO M 17.

(E) Hydrated Lime Anti-strip Additive

Use hydrated lime conforming to the requirements of ASTM C 977. Add hydrated lime used for anti-strip purposes at a rate of not less than 1.0% by weight of the total dry aggregate.

(F) Reclaimed Asphalt Shingle Material (RAS)

Reclaimed asphalt shingles (RAS) are materials produced as a by-product of the manufacturing process for roofing shingles. Process the RAS by ambient grinding or granulating methods such that 100% will pass the 1/2" sieve when tested in accordance with AASHTO T-27. Perform the test on ground asphalt shingles prior to extraction of the asphalt. The use of discarded shingles or shingle scrap from re-roofing of commercial or residential buildings will not be allowed.

(G) Reclaimed Asphalt Pavement (RAP)

Use reclaimed asphalt pavement that meets all requirements specified for the following classifications

(1) Millings

Existing reclaimed asphalt pavement (RAP) that is removed from the original location by a milling process as specified in Section 607.

(2) Processed RAP

RAP that is processed in some form (possibly by crushing or use of a blending method) to produce a uniform gradation and binder content in the RAP prior to use in a recycled mix. Process RAP so that all materials will pass a 2" sieve prior to introduction into the plant mixer unit. Millings are considered processed provided it has a uniform gradation and binder content and does not contain oversize material.

(3) Unprocessed RAP

RAP in the form as removed from the original location that has not been processed for gradation and binder content uniformity. Different sources of unprocessed RAP may be stockpiled together provided it is generally free of contamination and will be processed prior to use in a recycled mix. RAP contamination in the form of excessive dirt, debris, clean stone, concrete, etc. will not be allowed. Incidental amounts of dirt, concrete, and clean stone will be acceptable.

(4) New Source RAP

New source RAP will be classified into 2 categories:

(a) Millings from a different source than that of the millings used for the recycled mix design process, and that are not to be further processed, will be considered a new source RAP.

(b) All processed RAP other than that included in the original stockpile sampled and approved for the recycled mix design will be considered a new source RAP.

After a stockpile of processed RAP or millings has been sampled and mix designs made from these samples, do not add new source RAP to the original stockpile without prior field testing to insure gradation and binder uniformity. New source RAP shall be sampled before blending with the existing stockpile.

Store new source RAP in a separate stockpile until the material can be sampled and tested for comparison with the original recycled mix design data. New source RAP may also be placed against the existing stockpile in a linear manner provided it is sampled for mix design conformity prior to its use in the recycled mix.

Field approval will be based on Table 1012-2 below and volumetric mix properties on the mix with the new source RAP included. Provided the Table 1012-2 tolerances are met, volumetric properties of the new mix will then be performed. If all volumetric mix properties meet the mix design criteria for that mix type, the new source RAP may continue to be used.

If the gradation, binder content, or any of the volumetric mix properties are not within the allowable tolerances, do not use the new source RAP unless approved by the Engineer. A decision to not use the stockpile, adjust the JMF, or redesign the mix will be made.

TABLE 1012-2
NEW SOURCE RAP GRADATION and BINDER TOLERANCES
(Apply Tolerances to Mix Design Data)

Mix Type	0-15% RAP			15^{+}-25 % RAP			25^{+} % RAP		
Sieve	**Base**	**Inter.**	**Surf.**	**Base**	**Inter.**	**Surf.**	**Base**	**Inter.**	**Surf.**
$P_{b,}$ %		± 0.7%			± 0.4%			± 0.3%	
1 1/2"	±10	-	-	±7	-	-	±5	-	-
3/4"	±10	±10	-	±7	±7	-	±5	±5	-
1/2"	-	±10	±6	-	±7	±3	-	±5	±2
3/8"	-	-	±8	-	-	±5	-	-	±4
No. 4	±10	-	±10	±7	-	±7	±5	-	±5
No. 8	±8	±8	±8	±5	±5	±5	±4	±4	±4
No. 16	±8	±8	±8	±5	±5	±5	±4	±4	±4
No. 30	±8	±8	±8	±5	±5	±5	±4	±4	±4
No. 50	-	-	±8	-	-	±5	-	-	±4
No. 200	±4	±4	±4	±2	±2	±2	±1.5	±1.5	±1.5

1012-2 AGGREGATES FOR ASPHALT SURFACE TREATMENT

(A) General

Use coarse aggregate consisting of crushed stone, crushed gravel, crushed slag, or other inert material having similar characteristics. Adequately wash coarse aggregate so that it is free from clay, loam, dust, and other adherent materials.

Adequately clean all fine aggregate so that it is free from sticks, roots, visible lumps of clay, or other unsatisfactory material prior to use.

(B) Gradation

Use standard size No. 5, No. 67, No. 78M, or Lightweight coarse aggregate for mat or seal coat as required by Table 660-1, unless otherwise required by the contract. Use aggregate meeting the applicable gradation requirements of Table 1012-3.

Remix aggregate that has become segregated until it meets the applicable gradation requirements.

TABLE 1012-3
AGGREGATE GRADATION, COARSE AGGREGATE, ASPHALT SURFACE TREATMENT

STD SIZE	PERCENTAGE OF TOTAL BY WEIGHT OF PASSING																REMARKS
	2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#10	#16	#30	#40	#50	#80	#100	#200	
5		100	90-100	20-55	0-10	0-5										0-*0.6	AST Mat coat, Sediment Control Stone
67			100	90-100		20-55	0-10	0-5								0-*0.6	AST Mat coat
78M				100	98-100	75-100	20-45	0-15								0-*0.6	Asphalt Plant Mix Pavement, AST Weep Hole Drains, Str. Concrete
LIGHT WEIGHT					100	80-100	5-40	0-20		0-10						0-2.5	AST

(C) Fractured Faces

Use coarse aggregate that contains at least 75 percent by weight of crushed pieces having 2 or more fractured faces, and at least 90 percent by weight of crushed pieces having 1 or more fractured faces on that portion retained on the No. 4 sieve.

(D) Soundness

The maximum weighted average loss of either coarse or fine aggregate when subjected to 5 cycles using sodium sulfate when tested in accordance with AASHTO T 104 is 15%.

(E) Toughness (Resistance to Abrasion)

The maximum percentage loss of course aggregate for asphalt surface treatment when tested in accordance with AASHTO T 96 is 55%.

(F) Blending of Aggregates

Blending of two or more aggregates will not be permitted regardless of the origin of the aggregates if any one of the aggregates fails to meet the requirements for soundness or resistance to abrasion.

(G) Weight of Slag

The minimum weight of crushed slag is 70 pounds per cubic foot as determined in accordance with AASHTO T 19.

1012-3 BLOTTING SAND

Blotting sand is fine aggregate consisting of natural sand, commercial sand, manufactured sand, coarse screenings, or other inert material having similar characteristics. The requirements of Subarticles 1012-2 (D) and 1012-2 (F) will be applicable to blotting sand. Adequately clean the fine aggregate so that it is free from sticks, roots, visible lumps of clay, or other unsatisfactory material prior to use.

1012-4 LIGHTWEIGHT AGGREGATE

Lightweight aggregates used in asphalt surface treatments shall be produced by the rotary kiln process and shall come from an approved Department source meeting applicable requirements of Section 1005 and 1006. The aggregate shall also meet the requirements of ASTM C330, Lightweight Aggregate for Structural Concrete (AASHTO M195), with the exception of Sections 3, 6, 8, and any other references to concrete samples or concrete strength.

TABLE 1012-4
Lightweight Physical Properties

Property	Specification (maximum)	Test Procedure
Sodium Sulfate Soundness	5%	AASHTO T19
Los Angeles Abrasion	45%	AASHTO T96 (B grading)
Percent Absorption	10%	AASHTO T19
Micro-Deval	18%	AASHTO TP58-02

SECTION 1014
AGGREGATE FOR PORTLAND CEMENT CONCRETE

1014-1 FINE AGGREGATE

(A) General

Use fine aggregate from sources participating in the Department's Aggregate Quality Control/Quality Assurance Program as described in Section 1006. A list of sources participating in the Department's Quality Control/Quality Assurance Program in North Carolina and adjoining states is available from the Department's Laboratory in Raleigh.

Use fine aggregate consisting of natural sand or manufactured sand having clean, durable, hard, uncoated particles, or other inert materials having similar characteristics. Produce manufactured sand from fractured stone material. Use fine aggregate free from dirt, wood, paper, burlap, and all other foreign material.

To permit excess water to drain and the moisture content to become uniform, stockpile the aggregates either at the producer's plant or at the batch plant site for at least 24 hours before use in the concrete. Build open stockpiles of fine aggregate at the batch plant on concrete surfaces. Do not add new material to the stockpile during the 24 hour period. When the aggregates have a low and uniform moisture content and the consistency of the concrete can be satisfactorily controlled without stockpiling the aggregates for 24 hours, the minimum stockpiling period may be reduced or waived entirely by the Engineer.

The Division of Highways' list of approved sources of fine aggregate shows the target fineness modulus of each aggregate as established by the producer. Do not use fine aggregate with a fineness modulus that varies more than 0.2 from the target value until the concrete mix proportions are adjusted.

(B) Soundness

When subjected to 5 cycles of the soundness test, the weighted average loss shall not be more than 15 percent.

(C) Deleterious Substances

The amount of deleterious substances shall not exceed the following:

Substance	Maximum Permissible Percentage
Clay Lumps and Friable Particles	2.0 by weight (Natural sand) 1.0 by weight (Manufactured sand)

The percentage of deleterious substances will be determined in accordance with AASHTO T112.

(D) Organic Impurities

The color of each source of fine aggregate will be determined annually in accordance with AASHTO T21. Should the fine aggregate show a darker color than samples previously approved from the same source, withhold its use until tests have been made to determine the quality of the sand.

(E) Mortar Strength

Mortar made with the fine aggregate shall have a compressive strength at the age of 3 and 7 days using Type III portland cement, or 7 and 28 days using Type I or II portland cement, of not less than 95 percent of that developed by a comparison mortar. Make the comparison mortar with the same cement, graded Ottawa sand with a fineness modulus of 2.40 plus or minus 0.05, and the same water-cement ratio and consistency as the test mortar. Test the mortar strength in accordance with AASHTO T 106.

Fine aggregate that fails to meet the requirements of the preceding paragraph for mortar strength may be used with the approval of the Engineer, provided that when it is tested in concrete cylinders the compressive strength of the concrete at 14 days is equal to or greater than the strength of cylinders made with an identical mix using an acceptable sand.

(F) Gradation

Natural sand shall meet the gradation requirements for standard size No. 2S fine aggregate. Manufactured sand shall meet the gradation requirements for standard size No. 2MS fine aggregate.

(G) Blending Fine Aggregate

Blending fine aggregates to obtain the required gradation will be permitted if test results of each aggregate meet the durability requirements and test results of the combination indicate acceptable quality. Blend aggregates by weighing them separately at the time of batching or by other means acceptable to the Engineer.

When natural sand is blended with natural sand, the blend shall meet the gradation requirements for No. 2S fine aggregate. When manufactured sand is blended with natural sand or with manufactured sand, the blend shall meet the gradation requirements for No. 2MS fine aggregate and neither component can exceed the gradation limits on the No. 200 sieve shown in Table 1005-2.

(H) Siliceous Particle Content

Manufactured sand shall have a siliceous particle content of not less than 25 percent when used in concrete surfaces exposed to traffic. The siliceous particle content will be determined by NCDOT Chemical Procedure C-9. Copies of this test procedure are available upon request from the Materials and Tests Unit.

1014-2 COARSE AGGREGATE

(A) General

Use coarse aggregate from sources participating in the Department's Aggregate Quality Control/Quality Assurance Program as described in Section 1006. A list of these sources in North Carolina and adjoining states is available from the Materials and Tests Unit in Raleigh.

Use coarse aggregate that consists of crushed stone, crushed or uncrushed gravel, crushed air-cooled blast furnace slag, or other inert materials that have similar characteristics. Wash all coarse aggregate for portland cement concrete to remove clay, loam, dust, and similar adherent materials unless otherwise permitted by the Engineer in writing. Keep coarse aggregate free from dirt, wood, paper, burlap, and all other foreign material.

To permit excess water to drain and the moisture content to become uniform, stockpile the aggregates either at the producer's plant or at the batch plant site for at least 24 hours before use in the concrete. Build open stockpiles of coarse aggregate at the batch plant on concrete surfaces. Do not add new material to the stockpile during the 24 hour period. Where the aggregates have low and uniform moisture content and the consistency of the concrete can be satisfactorily controlled without stockpiling the aggregates for 24 hours, the minimum stockpiling period may be reduced or waived entirely by the Engineer.

Do not mix coarse aggregate from different sources or use it in alternate batches except where permitted by the Engineer in writing. Blending of coarse aggregates to obtain the required gradation will be permitted if the different sizes are from the same source. Blend coarse aggregates by weighing them separately at the time of batching or by other means acceptable to the Engineer.

(B) Soundness

When subjected to 5 cycles of the soundness test the weighted average loss shall not exceed 15 percent. For concrete with a 28 day design compressive strength greater than 6,000 psi, the loss shall not exceed 8%.

(C) Deleterious Substances

The amount of deleterious substances shall not exceed the following:

Substance	Maximum Permissible Percentage
Clay Lumps and Friable Particles	3.2 by weight

Determine the percentage of deleterious substances in accordance with AASHTO T112.

(D) Resistance to Abrasion

The percentage of wear of crushed stone or gravel shall not exceed 55 percent. For concrete with a 28 day design strength greater than 6,000 psi, the wear shall not exceed 40%.

(E) Aggregate Sizes

(1) General

Use standard size No. 57, No. 67, or No. 78M coarse aggregate in portland cement concrete unless otherwise indicated.

(2) Latex Modified Concrete

Use standard size No. 78M coarse aggregate in latex modified concrete.

(3) Prestressed and Precast Concrete

Use No. 67 or No. 78M coarse aggregate in prestressed and precast concrete.

(4) Use of More Than One Size

All concrete used in a single component of any structure shall be made with the same size aggregate.

(5) Portland Cement Concrete Pavement

Use standard size No. 57, No. 57M, No. 67, or #78M coarse aggregate in concrete for portland cement concrete pavement unless otherwise specified by the Engineer.

(6) Sand Lightweight Concrete Use the following gradation for the lightweight coarse aggregate:

Sieve Size	Passing Square Opening Sieves (Percent by Weight)
1”	100
3/4”	90 - 100
3/8”	10 - 50
No. 4	0 - 15

(F) Gradation

All coarse aggregate shall meet the gradation requirements for the standard size used.

SECTION 1016
SELECT MATERIAL

1016-1 DESCRIPTION

Select material is suitable material classified by gradation and performance characteristics as shown in this section. Use select material called for on the contract.

1016-2 USES

Select material may be specified for use in:

Subgrade	Slope and shoulder embankment
Backfill in undercut	Rock embankment in open water
Core material	Material placement over fabric
Foundation conditioning	Pipe backfill

With written approval and without additional compensation, a higher class of material may be substituted than stated in the contract.

1016-3 CLASSIFICATIONS

CLASS I

Class I Select Material is silty or clayey soil material meeting the requirements of AASHTO M145 for soil classification A-4. Soil materials which meet the requirements of AASHTO M145 for soil classification A-2, A-5, A-6 and A-7 are also acceptable provided such materials do not have a liquid limit (LL) greater than 50, nor a plasticity index (PI) of less than 7 or greater than 20.

CLASS II

Type 1 - Select Material is a fine aggregate material consisting of crushed stone screenings (washed or unwashed) meeting the following gradation:

Sieve	**% Passing**
3/8 in	100
#4	80 - 100
#10	65 - 95
#40	25 - 55
#200	0 – 20
LL	<= 30
PI	<= 6

Type 2 - Select Material is a granular soil material meeting the requirements of AASHTO M145 for soil classifications A-2-4 with a maximum PI of 6 and A-4 soil containing 45% maximum passing a No. 200 sieve and a maximum PI of 6.

When a type is not specified, either type may be used, but no additional compensation will be made.

CLASS III

Type 1 - Select Material is a natural or manufactured fine aggregate material meeting the gradation requirements of standard size 2S or 2MS in Table 1005-2 as described in Sections 1005 and 1006.

Type 2 - Select Material is a granular soil material meeting the requirements of AASHTO M145 for soil classification A-1 or A-3.

When a type is not specified, either type may be used, but no additional compensation will be made.

CLASS IV

Select Material is a coarse aggregate material meeting the gradation requirements of standard size ABC as described in Section1010.

CLASS V

Select Material is a coarse aggregate material meeting the gradation requirements of standard size 78M in Table 1005-1 as described in section 1005 and 1006.

CLASS VI

Select Material is a coarse aggregate material meeting the gradation requirements of standard size 57 in Table 1005-1 as described in section 1005 and 1006.

Class VII

Select Material is clean, unweathered durable, blasted rock material with the following gradation:

(A) At least 50% of the rock has a diameter of from 1 1/2 feet to 3 feet

(B) 40% of the rock ranges in size from 2" to 1 1/2 feet in diameter.

(C) Not more than 10% of the rock is less than 2" in diameter. (No rippable rock will be permitted)

SECTION 1018
BORROW MATERIAL

1018-1 GENERAL

Borrow excavation is approved material meeting the requirements for the particular embankments, backfill, or other use intended. Material that contains roots, root mats, stumps, or other unsatisfactory material will not be acceptable.

1018-2 APPROVAL OF BORROW SOURCE

The approval of borrow sources is subject to the requirements of Section 230.

Criteria for Acceptance of Borrow Material

(A) Statewide Criteria: (See exceptions in II)

Only natural earth materials may be used as borrow material. Any other materials are subject to rejection (See II-b).

Soil with P.I. of 25 or less ..... Acceptable

Soil with P.I. of 26 through 35 Acceptable, but not to be used in top 2 feet of embankment or backfill.

Soil with P.I. of more than 35..... Not Acceptable

(B) Exceptions to Statewide Criteria:

(1) Soils in the Coastal Plain (area described below) will be accepted in accordance with the following:

Soil with P.I. of 15 or less ..... Acceptable

Soil with P.I. of 16 through 20 ..... Acceptable, but not to be used in top 2 feet of embankment or backfill.

Soil with P.I. of more than 20 ..... Not Acceptable.

Division 1 ..... Entire Division except Northampton (West of I-95)

Division 2 ..... Entire Division

Division 3 ..... Entire Division

Division 4 ..... Edgecombe, Wayne, Johnston (East of US 301), Wilson (East of I-95), Nash (East of I-95), Halifax (East of I-95)

Division 6 ..... Bladen, Columbus, Robeson, Cumberland, Harnett (South of NC 27)

Division 8 ..... Scotland, Hoke, Moore (Southeast of US 15-501, NC 73, NC 211), Richmond (East of US 220 North and US 1 South)

Also applicable to the flood plains of the Roanoke, Tar, Neuse, Cape Fear, and Lumber Rivers and their tributaries that is outside the above described areas.

(2) Waste or by-products from industrial processes or mining operations are not acceptable except by specific, written approval.

(3) When tested, soils having a pH of less than 5.5 or an organic content more than 4.0% may be rejected.

(4) --- When material is to be utilized for placing embankments or backfilling of undercut areas that are excessively wet, the material shall consist of Select Material Class II, III or IV.

SECTION 1020
ASPHALT MATERIALS

1020-1 DELIVERY AND ACCEPTANCE OF ASPHALT MATERIALS

Asphalt materials are accepted at the source of shipment subject to the following conditions:

All asphalt transport tankers, including rail and truck tankers, shall have a sampling valve in accordance with Asphalt Institute Publication MS-18, Sampling Asphalt Products for Specification Compliance and ASTM D140, or a comparable device acceptable to the Engineer.

Each transport tanker delivering asphalt materials to the project or rail siding shall keep a running log showing the date, destination, and type and grade of material hauled on each trip. Print, stamp, or write in ink information appearing in the log and have available for examination upon request of the Engineer at any time.

Furnish with each shipment 2 copies of a delivery ticket. Have both copies accompany the shipment and deliver to the Engineer or his representative at the destination. The delivery ticket shall contain the following information:

Delivery ticket number,
date shipped,
state project or purchase order number,
NCDOT assigned batch number,
destination,
name of consignee,
trailer or car number,
supplier's storage tank or batch number,
quantity loaded in tons or gallons
specific gravity or pounds per gallon at 60°F
loading temperature,
net gallons at 60°F

When anti-strip additive is introduced into the asphalt binder, have the delivery ticket note the brand, grade, and percentage or quantity at which the additive was introduced.

The Contractor's asphalt materials supplier shall furnish to the Materials and Tests Unit a typical viscosity-temperature chart at the beginning of each calendar year and a new chart whenever a change in production results in a shift of 5°F or more.

Furnish a statement of certification from the supplier and a separate statement of certification from the transporter. Sign each certification by an authorized representative of the supplier or transporter. Stamp, write, or print these certifications on the delivery ticket, or attach to the delivery ticket.

Unless otherwise approved by the Engineer, the following form shall be used in the supplier's certification:

This is to certify that this shipment of _____ gallons/liters or tons/metric tons of _____ grade asphalt including _____ gallons/liters of _____ anti-strip meet all requirements of NC Department of Transportation Specifications.

Signed _____

Authorized Representative of Supplier

When no anti-strip additive is included with the load, the supplier shall indicate zero (0) in the gallons field and "NA" in the anti-strip field on the above certification.

Unless otherwise approved by the Engineer, the following form shall be used in the transporter's certification:

This is to certify that this transport tank was clean and free from contaminating materials when loaded. The material transported on the previous load in this tanker was _____.

Signed_____

Authorized Representative of Transporter

Failure to sign the certifications by either the supplier or transporter will be cause to withhold use of the material until a sample can be taken and tested, except where an alternative testing and invoicing procedure has been pre-approved by the Engineer.

The Engineer reserves the right to sample and test any shipment regardless of whether or not the above conditions have been met and to reject any material not meeting the requirements of the Specifications.

1020-2 ASPHALT BINDER

Use Performance Graded Asphalt Binder meeting the requirements of AASHTO M 320 Table 1. See Article 610-3 for the specified grades. Submit a Quality Control Plan for asphalt binder production in conformance with the requirements of AASHTO R 26 to the Materials and Tests Unit.

NCDOT Performance Graded Asphalt Binder Quality Control/Quality Assurance Program shall be implemented in accordance with Subsection 1020-10.

Polymer Modifiers for Asphalt Binder – Where modification of the asphalt binder is required to meet the specified grade, accomplish the modification using a Styrene Butadiene Styrene (SBS), Styrene Butadiene Rubber (SBR), Styrene Butadiene (SB) polymer or other modifiers approved by the Engineer to modify asphalt to meet the grade specified prior to delivery to the asphalt plant. Other polymers shall be pre-approved and listed by the NCDOT Materials and Tests Unit. Air blown asphalt will not be permitted.

1020-3 PRIME COAT MATERIALS

Supply prime coat materials from pre-approved sources in accordance with Materials and Tests Unit Method A and listed by the Department Materials and Tests Unit. Verification samples taken at the point of application (destination) are subject to the following conditions:

(A) All prime coat materials shall be delivered to the project ready for use.

(B) Sampling will be made at the point of application. The Department reserves the right to sample all materials used for prime coat applications, either at the destination or at the point of origin, and to withhold acceptance of material until analysis of such samples have been made. When a material meets specification requirements, but has a history of unsatisfactory service performance, its use for construction or maintenance purposes may be restricted by the Department and such restriction will be noted on the list of approved products.

(C) Proposed materials for Prime Coat Applications that are not listed as approved will be investigated upon the request of the supplier or Contractor. The maximum Volatile Organic Compounds for the products (materials) on the approved list for prime coat applications shall not exceed 6.8 ounces per gallon of material or the current applicable regulatory limit. Submit a Material Safety Data Sheet (MSDS), as well as a two quart sample from three different batches of the same material to the Materials and Tests Unit for evaluation.

(D) The Sand Penetration results for a material used as a prime coat are:

Penetration Depth (millimeter)	12 minimum
Penetration Time (seconds)	90 maximum

Copies of the Sand Penetration Test procedure are available upon request from the Materials and Tests Unit.

(E) Materials used as a prime coat shall have a minimum rating of *Fair* on the No-Tracking Time Test. Copies of the No-Tracking Time Test procedures are available upon request from the Materials and Tests Unit.

(F) Materials used as a prime coat shall have a minimum rating of *Fair* on the Coating Ability and Water Resistance Test in Accordance with AASHTO T-59.

(G) For materials that will be stored longer than one day at the destination point (Contractors'/Division' tanks), submit to the Engineer a Certified Laboratory Report on the performance of the material for Storage Stability Test in accordance with AASHTO T-59.

(H) The diluted materials shall be tested for asphalt residue percent in accordance with AASHTO T-59, Section 55, Residue by Evaporation, and shall have a minimum asphalt residue percent of 15.

1020-4 SILICONE

Silicone Additives shall be pre-approved and listed by the NCDOT Materials and Tests Unit.

1020-5 BLANK

1020-6 EMULSIFIED ASPHALT, ANIONIC

Emulsified asphalt, except for Grade RS-1H, shall meet the requirements of AASHTO M140.

Emulsified asphalt, Grade RS-1H, shall meet the requirements of AASHTO M140 for Grade RS-1 except as follows:

The penetration of residue shall be a minimum of 50 and a maximum of 100.

Perform the testing of the asphalt in accordance with AASHTO T59 except as follows:

(A) The residue by evaporation will be performed using a hot plate in lieu of an oven.

(B) The determination of coating test, solubility of residue, and ash will be made when deemed necessary by the Engineer.

(C) Materials and Tests Method A-24, Test For Compatibility of Aggregate and Emulsified Asphalt, is used to determine the coating ability and water resistance using either crushed or uncrushed aggregate from a source selected by the Department.

1020-7 EMULSIFIED ASPHALT, CATIONIC

Cationic emulsified asphalt, except for Grade CRS-1H, shall meet the requirements of AASHTO M208. Cationic emulsified asphalt, Grade CRS-1H, shall meet the requirements of AASHTO M208 for Grade CRS-1 except as follows:

(A) The residue after distillation shall be a minimum of 55 percent.

(B) The penetration of residue shall be a minimum of 50 and a maximum of 100.

(C) Viscosity, Saybolt Furol at 77°F shall be a minimum of 20 and a maximum of 100.

Perform the testing of the asphalt in accordance with AASHTO T59 except as follows:

(A) Residue by evaporation will be performed using a hot plate in lieu of an oven with a maximum temperature of 400 degrees F however referee testing will be performed in accordance with the current ASTM or AASHTO Standard Test Methods for Cationic or Anionic Emulsified Asphalts.

(B) The determination of coating test, oil distillate, pH, solubility of residue, ash, and particle charge will be made when deemed necessary by the Engineer.

(C) Materials and Tests Method A-24, Test For Compatibility of Aggregate and Emulsified Asphalt, is used to determine the coating ability and water resistance using either crushed or uncrushed aggregate from a source selected by the Department.

All polymer modified cationic asphalt emulsion materials are subject to the requirements of Section 1020. The following exceptions apply to CRS-2P:

(A) The material shall contain Styrene Butadiene Rubber, Styrene Butadiene Styrene, or Styrene Butadiene.

(B) The viscosity at 122 degrees F shall be a minimum of 100 seconds and a maximum of 400 seconds.

(C) The sieve shall be a maximum of 0.15%.

(D) The 24 hour storage stability shall not exceed 1%.

(E) The residue by evaporation (oven evaporation) shall be a minimum of 65%.

(F) The elastic recovery (AASHTO T301) at 50 degrees F shall be a minimum of 55%.

(G) The ring and ball softening point (AASHTO T53) shall be a minimum of 110 degrees F.

(H) Polymer content may be analyzed if deemed necessary by the Engineer

1020-8 ANTI-STRIP ADDITIVE

Anti-strip additive may either be hydrated lime or a chemical additive or a combination of both. The additive shall be capable of preventing the separation of the asphalt binder from the aggregate and achieving the required tensile strength ratio (TSR) on the asphalt mix when tested in accordance with AASHTO T 283 as modified by Department.

When lime is used, it shall conform to the requirements of ASTM C 977.

When chemical additive is used, it shall be added to the asphalt binder prior to introduction into the mix. Do not use any chemical additive or particular concentration of chemical additive found to be harmful to the asphalt material or which causes the performance grading of the original asphalt binder to be out of specifications for the grade required.

1020-9 WATERPROOFING AND DAMPPROOFING MATERIALS

(A) Asphalt Primer

Asphalt primer shall meet the requirements of ASTM D-41.

(B) Asphalt Binder

Asphalt Binder shall meet the requirements of Article 1020-2, Grade PG 64-22.

(C) Tar

Tar shall meet the requirements of ASTM D490.

(D) Fabric

Woven cotton fabric for waterproofing shall meet the requirements of ASTM D-173.

1020-10 ASPHALT BINDER QUALITY CONTROL/QUALITY ASSURANCE

The Performance graded asphalt binder quality control quality assurance program is designed to give asphalt binder producers/suppliers (henceforth Producer designates Producer/Supplier) more responsibility for controlling the quality of material they produce and to utilize the quality control information they provide in the acceptance process by the Department. It requires asphalt binder producers to perform quality control sampling, testing and record keeping on materials they ship for use by the Department. Also, it documents that the Department will perform quality assurance sampling, testing and record keeping confirming the performance of the producers' control plan. In addition, the Producer is required to participate in Independent Assurance – comparative sample activities. The program is described in the *Performance Graded Asphalt Binder Quality Control/Quality Assurance Program Manual*.

The types of samples and the lot sizes required by the Producers and the Department are described in detail in the *Performance Graded Asphalt Binder Quality Control/Quality Assurance Program Manual.*

Acceptance or rejection of material will be based on the total program. Therefore, a comparison of the Quality Control, Quality Assurance, and other sample data may be used by the Department for acceptance or rejection of a lot of material.

Participation in this program does not relieve the producer of the responsibility of complying with all requirements of the *Department's Specifications*.

An electronic copy of the Program Manual may be obtained by accessing the Department's website or by contacting the Materials and Tests Unit Chemical Laboratory.

SECTION 1024
MATERIALS FOR PORTLAND CEMENT CONCRETE

1024-1 PORTLAND CEMENT

(A) General

Supply portland cement that meets the requirements of AASHTO M85 for Type I, II, or III except that the maximum fineness requirements of AASHTO M85 do not apply to cement used in precast concrete products. Throughout these Specifications Types I and II cement are referred to as regular portland cement and Type III as high early strength portland cement.

For concrete mix designs that contain an aggregate that has exhibited alkali-silica reactivity as documented by the Department, ensure that the alkali content of the cement, expressed as sodium-oxide equivalent, does not exceed 0.4%. However, cement with a higher alkali content not to exceed 1% is allowed if used with Class F fly ash, ground granulated blast furnace slag, microsilica, or other Department approved pozzolans in the amounts shown below. For all other mix designs, ensure that the alkali content of the cement, expressed as sodium oxide equivalent, does not exceed 0.6%; however, cement with a higher alkali content not to exceed 1% is allowed if used with Class F fly ash, ground granulated blast furnace, microsilica, or other Department approved pozzolans in the following amounts:

Class F Fly Ash	20% by weight of required cement content, with 1.2 lbs. Class F fly ash per lb. of cement replaced.
Ground Granulated Blast Furnace Slag	35% - 50% by weight of required cement content, with 1 lb. slag per lb. of cement replaced.
Microsilica	4-8% by weight of required cement content, with 1 lb. microsilica per lb. of cement replaced.

Type IP or IS blended cement is allowed for the cement-and-fly-ash or cement-and-slag portion of the mix.

Use white cement that meets the requirements of ASTM C150, except that the ferric oxide content is limited to 0.5 percent.

Use Type IP blended cement that meets the requirements of AASHTO M240, except that the pozzolanic content is limited to between 17 and 23 percent by weight and the constituents are interground.

Use Type IS blended cement that meets the requirements of AASHTO M240 except that the slag content is limited to between 35 and 50 percent by weight and the constituents are interground.

Do not use air-entraining portland cement.

Do not mix different types of cement, different brands of cement, or the same brand from different mills nor use them alternately except when authorized in writing by the Engineer.

Protect cement from contamination or damage during handling and storage. Do not use cement that is damaged, partially set, lumpy or caked.

(B) Basis of Acceptance, Cast-in-Place Construction

Furnish the Engineer 5 copies of a Type 5 Materials Certification in accordance with Article 106-3 from each supplier furnishing portland cement concrete. Ensure that the Certification states that the portland cement used on the project meets the requirements of Article 1024-1. Upon receipt of this certification the cement is useable prior to testing by the Department.

All cement is sampled and tested by the Department as it arrives on the project at such frequency as established by the Department.

(C) Basis of Acceptance, Precast Concrete Products

All cement is sampled and tested by the Department as it arrives at the precasting plant at such frequency as established by the Department.

1024-2 AGGREGATE

Provide aggregate that meets the requirements of Section 1014.

1024-3 ADMIXTURES

(A) Basis of Acceptance

Admixtures from an approved source are accepted without prior testing. Do not use admixtures that are not from an approved source until the admixture is approved by the Department.

(B) Approved Sources

An approved source is considered to be any manufacturer of admixtures who complies with the requirements of this subarticle.

The manufacturer is required to submit to the Materials and Tests Unit certified reports of tests that show that the admixture meets the applicable Specifications. Test shall be performed in a laboratory certified by the Cement and Concrete Reference Laboratory of the National Bureau of Standards.

Admixtures that contain chloride other than calcium chloride as provided herein are not permitted. The manufacturer is required to state in writing that no chloride was added during it's the manufacture of the admixture.

After an admixture is accepted, the manufacturer is required to submit to the Materials and Tests Unit on or prior to February 1 of each year a notarized certification that shows that the material is of the same composition as originally accepted and has not been changed or altered. If an admixture is changed or altered,

approval of the source in accordance with the above requirements is necessary before using the admixture.

The Engineer has the option to make any or all tests deemed desirable to verify the manufacturer's certification. Failure of the admixture in such tests is cause for discontinuation of its use. Failure of an admixture to perform satisfactorily under job conditions is cause for rejection of the source.

The Engineer maintains a list of approved sources on file.

(C) Air Entraining Agent

Provide air entraining agents that meet the requirements of AASHTO M154.

(D) Chemical Admixtures

(1) Set Retarding Admixtures

Use set retarding admixtures that meet the requirements of AASHTO M194 for Type D - water reducing and retarding admixtures.

(2) Water Reducing Admixtures

Use water reducing admixtures that meet the requirements of AASHTO M194 for Type A admixtures.

(3) Calcium Chloride

Provide calcium chloride that meets the requirements of AASHTO M144 for Type 2, concentrated flake, pellet, or other granular calcium chloride. The Engineer may waive the gradation requirement.

(4) High-Range Water Reducing Admixtures

Use high-range water reducing admixtures that meet the requirements of AASHTO M194 for Type F or Type G.

(5) Calcium Nitrite Corrosion Inhibitor

Use an approved calcium nitrite corrosion inhibitor that contains 30 % solids.

(E) OTHER ADMIXTURES

Admixtures not otherwise classified will be reviewed on a case-by-case basis by the Materials and Tests Unit.

1024-4 WATER

Ensure that water used to condition, wash, or as an integral part of materials does not contain any compound that will adversely impact the material or its long term performance. Use water with a pH in the range of 4.5 to 8.5, a chloride content no greater than 250 parts per million (ppm), a total solids content no greater than 500-ppm, and no dissolved organic matter.

Test all water from wells, streams, ponds and public water supplies in coastal North Carolina and all out of state locations unless the Engineer waives the testing requirement.

Water from a municipal water supply in a non-coastal area may be accepted by the Engineer without testing.

1024-5 FLY ASH

Provide fly ash that meets ASTM C618 for Class F or Class C, except ensure that the loss on ignition does not exceed 4%. Table 1A, Supplementary Optional Chemical Requirement of ASTM C618, applies to Class F fly ash. Use fly ash that also meets the optional physical requirements for uniformity shown in Table 2A of ASTM C618.

Do not use Class C fly ash in portland cement concrete if the alkali content of the cement exceeds 0.4%.

Furnish the Engineer 5 copies of a Type 4 Materials Certification from each fly ash supplier in accordance with Article 106-3. The laboratory that performs the tests included in the certification shall be regularly inspected by the Cement and Concrete Reference Laboratory (CCRL) for fly ash testing and shall authorize CCRL to submit a copy of the inspection reports directly to the Materials and Tests Unit of the Department. State in the certification that the fly ash used on the project meets the requirements of Article 1024-5. Upon receipt of this certification, use of the fly ash is allowed prior to testing by the Department.

All fly ash is sampled and tested by the Department as it arrives on the project at such frequency as established by the Department.

1024-6 GROUND GRANULATED BLAST FURNACE SLAG

Use blast furnace slag that meets the requirements of AASHTO M302, Grade 100.

Furnish the Engineer 5 copies of a Type 5 Certification from each fly ash supplier in accordance with Article 106-3. State in the certification that the blast furnace slag used in the concrete meets the requirements of Article 1024-6. Upon receipt of this Certification, use of the slag is allowed prior to testing by the Department. All slag is sampled and tested by the Department as it arrives on the project at such frequency as established by the Department.

1024-7 SILICA FUME

Provide silica fume (microsilica) that meets the requirements of Tables 1, 2, and 3 of ASTM C 1240. Furnish the Engineer 5 copies of a Type 4 Materials Certification from each silica fume supplier in accordance with Article 106-3. State in the certification that the silica fume used on the project meets the requirements of Article 1024-7. Upon receipt of this certification, use of the silica fume is allowed prior to testing by the Department. All silica fume is sampled and tested by the Department as it arrives on the project at such frequency as established by the Department.

SECTION 1026
CURING AGENTS FOR CONCRETE

1026-1 GENERAL

All curing agents shall be free from impurities that may be detrimental to the concrete. Do not use curing agent until the applicable tests have been performed and the Engineer has approved the curing agent.

1026-2 LIQUID MEMBRANE CURING COMPOUNDS

(A) General

Liquid membrane curing compounds shall meet the requirements of AASHTO M148, except that when tested in the water retention test described in AASHTO T155 the curing compound shall restrict the loss of water in the test specimen at the time of application of the compound to not more than 0.007 ounces per square inch.

The curing compound shall be Type 2, white pigmented, except that where clear type is required for a particular application, the curing compound shall be Type 1D, clear or translucent with fugitive dye.

Deliver curing compound in the manufacturer's original clean, sealed containers. Legibly mark each container with the name of the manufacturer, the name of the compound, the type of compound, the manufacturer's batch number, the date of manufacture, and the manufacturer's recommended shelf life.

Do not use curing compound that has been in storage for more than one year from the date of manufacture or more than the manufacturer's recommended shelf life, whichever is less.

(B) Test Procedures:

Curing compound will be tested in accordance with the test methods described or referred to in AASHTO M148 except as follows:

The size of molds for making test specimens will be approximately 5 1/2" in diameter by approximately 1" deep, or any other size selected by the Engineer.

1026-3 POLYETHYLENE FILM.

Polyethylene film shall meet the requirements of AASHTO M171 for white opaque polyethylene film, except that when tested for moisture retention efficiency the loss shall not be more than 0.007 ounces per square inch of surface area.

1026-4 WATER

All water used for curing concrete shall meet the requirement of Article 1024-4.

1026-5 BURLAP

Burlap shall meet the requirements of AASHTO M182. Any class of burlap will be acceptable.

Use new burlap or burlap that has been used for no purpose other than curing concrete. New burlap shall be free from starch, filler, or other substances added during manufacture, or shall be washed to remove such substances before use.

SECTION 1028
JOINT MATERIALS

1028-1 JOINT FILLER

Provide a nonbituminous type joint filler that meets AASHTO M153 for Type I, II, or III; or be a bituminous type that meets AASHTO M213. Furnish a Type 3 Manufacturer's Certification with each lot of the joint material supplied to each project.

1028-2 HOT APPLIED JOINT SEALER

Provide a hot applied joint sealer that conforms to ASTM D 6690. Furnish a Type 3 Manufacturer's Certification for each lot of the joint sealer supplied to each project.

1028-3 BLANK

1028-4 LOW MODULUS SILICONE SEALANT

Provide a cold applied, single component, chemically curing low modulus silicone sealant that meets ASTM D 5893 and this Specification. Acid cure sealants are not acceptable for use on portland cement concrete. Bond breakers shall meet the requirements of Article 1028-5.

(A) Silicone Sealant Types

Type NS – A non-sag silicone for use in sealing horizontal and vertical joints in portland cement concrete pavements and bridges. Tooling is required.

Type SL – A self-leveling silicone used to seal horizontal joints in portland cement concrete pavements and bridges. Tooling is not normally required.

(B) Requirements

Silicone sealant shall meet the following requirements in addition to ASTM D 5893:

TEST	REQUIREMENT
Peel (ASTM D 903 - bonded on concrete block)	Minimum of 20 lbs./in. of width with at least 75% cohesive failure.
Movement Capability and Adhesion (ASTM C 719)	No adhesive or cohesive failure after 10 cycles of test movements of +100% (extension) and –50% (compression)

Furnish a Type 3 Manufacturer's Certification for each lot of joint sealer material supplied to each project. Deliver each lot of sealant in containers plainly marked with the manufacturer's name or trademark, lot number, and date of manufacture.

1028-5 BOND BREAKER

Install silicone sealant over a bond breaker to prevent the sealant from bonding to the bottom of the joint. Use bond breakers that do not stain or adhere to the sealant and are chemically inert and resistant to oils.

Type L – A closed-cell expanded polyethylene foam backer rod. Use this backer rod in roadway and bridge joints and with Type NS silicone only.

Type M – A closed-cell polyolefin foam backer rod which has a closed-cell skin over an open cell core. Use this backer rod in roadway and bridge joints with both silicone sealant types.

Both types of backer rod shall meet the following requirements:

Density (ASTM D 1622) ..... 2.0 lb/ft^3 minimum

Tensile Strength (ASTM D 1623) ..... 25 psi minimum

Water absorption (ASTM C 509) ..... 0.5% by volume maximum

Type N – Provide bond breaking tape made from extruded polyethylene that has a pressure sensitive adhesive on one side. Bond breaking tape may be used with both types of silicone but is suitable for bridge joints only.

Bond breaking tapes shall be a minimum of 0.005" in thickness.

Furnish a Type 3 Manufacturer's Certification for each lot of bond breaker material supplied to each project.

SECTION 1032

CULVERT PIPE

1032-1 CORRUGATED METAL CULVERT PIPE

Use corrugated metal culvert pipe from sources meeting requirements of the Department's Brand Certification Program for metal culvert pipe. A list of these sources is available from the Materials and Test Unit's Central Laboratory. The Department will remove a manufacturer of metal culvert pipe from this program in the event that the monitoring efforts indicated that non-specification material is being provided or test procedures are not being followed.

The following types of steel and aluminum alloy pipe and all associated accessories may be accepted under this program.

(A) Corrugated metal culvert pipe, pipe arches and underdrain.

(B) Coated, paved and lined corrugated metal culvert pipe and pipe arches.

(C) Corrugated metal end sections, coupling band, and other accessories and hardware.

(D) Coated, paved, and lined metal end sections, coupling bands and accessories.

(E) Corrugated aluminum alloy structural plate pipe and pipe arches.

(F) Welded steel pipe

1032-2 CORRUGATED ALUMINUM ALLOY CULVERT PIPE

(A) Corrugated Aluminum Alloy Culvert Pipe

Corrugated aluminum alloy culvert pipe shall meet the requirements of AASHTO M196 except that Type IA pipe will not be permitted.

When elongated pipe is called for by the contract, use pipe that is shop formed to provide for a 5 percent vertical elongation.

Coupling bands with projections may be used for circumferential pipe, helical pipe, or a combination of both.

(B) Corrugated Aluminum Alloy Pipe Tees and Elbows

Corrugated aluminum alloy pipe tees and elbows shall meet all applicable requirements of AASHTO M196.

(C) Acceptance

Acceptance of corrugated aluminum alloy culvert pipe, and its accessories will be based on, but not limited to, visual inspections, classification requirements, check samples taken from material delivered to the project, and conformance to the annual Brand Registration.

Culvert pipe materials not meeting the above requirements will be rejected, unless written approval is obtained from the State Materials Engineer.

1032-3 CORRUGATED STEEL CULVERT PIPE

(A) Corrugated Steel Culvert Pipe and Pipe Arch

Corrugated steel culvert pipe and pipe arch shall meet the requirements of AASHTO M36 with the following exceptions:

(1) Coupling Bands

(a) Use corrugated coupling bands except as may be otherwise provided below.

(b) A hugger type corrugated band having one annular corrugation at each outside edge of the band will be acceptable.

(c) Coupling bands with projections may be used where it is necessary to join new pipe to existing pipe having helical corrugations at the joint locations. Use an approved sealer with this type of coupling band.

(d) Fasten coupling bands on the ends with a minimum of two 1/2" bolts.

(e) Annular corrugated bands shall have a minimum width of 10 1/2" where 2-2/3" by 1/2" corrugations are used.

(2) Corrugations

Where 1/4" deep corrugations are permitted by AASHTO M36, the maximum pitch of the corrugations shall be 1 7/8".

Where 3" x 1" corrugations are required, the Contractor will also be permitted to use 5" x 1" corrugations.

Pipe with helical corrugations shall have rerolled ends with a minimum of 2 annual corrugations at each end.

(3) Elongated Pipe

When elongated pipe is called for by the contract, use pipe that is shop formed to provide for a 5 percent vertical elongation.

(4) Lifting Straps

The pipe may be furnished either with or without lifting straps for handling. Attach the lifting straps by bolting or by welding. Bolt holes for attaching the straps shall be a smooth hole that is either punched or drilled. No burning of holes will be permitted. Design the lifting straps so that the holes can be plugged to prevent infiltration of backfill material.

Design the placement of lifting straps so as to ensure the pipe is equally supported along its axis.

(5) Coating Repair

Repair of galvanizing shall be in accordance with Section 1076-6.

(6) Type IA Pipe

Type IA pipe will not be permitted.

(7) Aluminized Pipe

Aluminized pipe may be used in lieu of galvanized pipe. Aluminized pipe shall meet all requirements of Subarticle 1032-3(A) except that the pipe and coupling bands shall be fabricated from aluminum coated steel sheet meeting the requirements of AASHTO M274.

(8) Marking Requirements

Pipe sections and special attachments for pipe 60" or larger diameter pipe shall be alphanumerically match-marked at the plant site before shipping. There may be additional markings as required by the Department's Brand Certification Program.

(B) Prefabricated Corrugated Steel Pipe End Sections

Corrugated steel end sections shall be in accordance with the details shown on the plans, and meet all applicable requirements of Subarticle 1032-3(A). Repair end sections on which the spelter coating has been bruised or broken either in the shop or in shipping in accordance with AASHTO M36.

(C) Corrugated Steel Pipe Tees and Elbows

Corrugated steel tees and elbows shall meet all applicable requirements of Subarticle 1032-3(A).

(D) Corrugated Steel Eccentric Reducers

Corrugated steel eccentric reducers shall meet all applicable requirements of Subarticle 1032-3(A), and the additional requirements shown below.

Construct the eccentric reducer so that the invert or flow line from the large pipe through the reducer and into the small pipe is a continuous straight line.

Make the reducer from the same thickness corrugated metals as the large diameter pipe. The reducing section may be riveted or welded.

(E) Acceptance

Acceptance of corrugated steel culvert pipe, and its accessories will be based on, but not limited to, visual inspections, classification requirements, check samples taken from material delivered to the project, and conformance to the annual Brand Registration.

Culvert pipe materials not meeting the above requirements will be rejected, unless written approval is obtained from the State Materials Engineer.

The reducing section shall reduce in diameter no more than 3" in 24" of length. Rivet or weld a 24" long constant diameter stub to each end of the reducing section to form the complete reducer.

Have the completed reducer show careful, finished workmanship in all particulars. Repair reducers on which the spelter coating has been bruised or broken either in the shop or in shipping in accordance with AASHTO M36. Reducers that show defective workmanship will be rejected. The following defects are considered to be evidence of poor workmanship, and the presence of any of them in any individual reducer will constitute sufficient cause for rejection:

(1) Not meeting required dimensions.
(2) Not of the specified shape.
(3) Uneven laps.
(4) Ragged or diagonal sheared edges
(5) Loose, unevenly lined or spaced rivets.
(6) Poorly formed rivet heads.
(7) Lack of rigidity.
(8) Dents or bends in the metal itself.
(9) Uneven welds.
(10) Gaps in welds

1032-4 COATED, PAVED, AND LINED CORRUGATED STEEL CULVERT PIPE

(A) Bituminous Coated Corrugated Steel Culvert Pipe and Pipe Arch

(1) Type A -- Fully Bituminous Coated

The pipe and pipe arch shall meet the requirements of Subarticle 1032-3(A) and be bituminous coated in accordance with the requirements of AASHTO M190 for Type A pipe. Do not coat coupling bands.

(2) Type B -- Half Bituminous Coated and Partially Paved

The pipe and pipe arch shall meet the requirements of Subarticle 1032-3(A) and be half bituminous coated and partially paved in accordance with the requirements of AASHTO M190 for Type B pipe. Do not coat coupling bands.

(3) Type C -- Fully Bituminous Coated and Partially Paved

The pipe and pipe arch shall meet the requirements of Subarticle 1032-3(A) and be fully bituminous coated and partially paved in accordance with the requirements of AASHTO M190 for Type C pipe. Do not coat coupling bands.

(4) Type D -- Fully Bituminous Coated and Fully Paved

The pipe and pipe arch shall be fully bituminous coated and fully paved as provided for Type C except that the pavement shall extend for the full circumference of the inside of the pipe. The inside diameter after paving shall not be less than 98 percent of the nominal diameter of the pipe. Do not coat coupling bands.

(B) Prefabricated Bituminous Coated Corrugated Steel Pipe End Sections

Bituminous coated corrugated steel end sections shall be in accordance with the details shown on the plans, and meet all applicable requirements of Subarticle 1032-4(A). Repair end sections on which the spelter coating has been bruised or broken either in the shop or in shipping in accordance with AASHTO M36. The pipe connector section shall be bituminous coated to match the adjacent pipe. Bituminous coating will not be required on the skirt section.

(C) Bituminous Coated Corrugated Steel Pipe Tees and Elbows

Bituminous coated corrugated steel tees and elbows shall meet all applicable requirements of Subarticle 1032-4(A).

(D) Bituminous Coated Corrugated Steel Eccentric Reducers

Bituminous coated corrugated steel eccentric reducers shall meet all applicable requirements of Subarticle 1032-3(D) and be bituminous coated as called for in Subarticle 1032-4(A).

(E) Optional Coatings for Bituminous Coated Pipe or Pipe Arch

A polymeric coating meeting the requirements of AASHTO M246 for Type B coating will be acceptable in lieu of bituminous coating wherever Type A fully bituminous coated corrugated steel culvert pipe or pipe arch is called for by the contract.

Pipe meeting the applicable requirements of Subarticle 1032-3(A) for aluminized pipe may be substituted for bituminous coated galvanized steel culvert pipe as provided in paragraphs 1 through 5 below, except that paragraphs 1, 2, and 3 will not apply in the counties of Beaufort, Bertie, Bladen, Brunswick, Camden, Carteret, Chowan, Columbus, Craven, Currituck, Dare, Gates, Hertford, Hyde, Jones, Martin, New Hanover, Onslow, Pamlico, Pasquotank, Pender, Perquimans, Tyrrell, and Washington.

(1) In lieu of Type A, Fully Bituminous Coated galvanized pipe, aluminized pipe without a bituminous coating, may be used.

(2) In lieu of Type B, Half Bituminous Coated and Partially Paved galvanized pipe, Type B aluminized pipe may be used. Type B aluminized pipe is aluminized pipe which has been half bituminous coated and partially paved as required by Subarticle 1032-4(A)(2). Type B: In lieu of Type B, Half Bituminous coated and Partially Paved galvanized pipe, aluminized pipe or polymeric coated pipe without bituminous coating and paving may be used.

(3) In lieu of Type C, Fully Bituminous Coated and Partially Paved galvanized pipe, Type B aluminized pipe may be used as Type C: In lieu of Type C, Fully Bituminous Coated and Partially Paved galvanized pipe, aluminized pipe or poylmeric coated pipe without a bituminous coating and paving may be used.

(4) In lieu of Type D, Fully Bituminous Coated and Fully Paved galvanized pipe, Type D aluminized pipe may be used. Type D aluminized pipe is aluminized pipe which has been fully bituminous coated and fully paved as required by Subarticle 1032-4(A)(4).

(5) The above provisions pertaining to the substitution of aluminized pipe for galvanized pipe will also apply to the substitution of aluminized pipe arch, end sections, tees, elbows, and eccentric reducers for galvanized pipe arch, end sections, tees, elbows, and eccentric reducers.

(F) Concrete Lined Corrugated Steel Culvert Pipe

Concrete lined corrugated steel culvert pipe, tees, and elbows shall be fully concrete lined for the full circumference of the inside of the pipe and meet the requirements of ASTM A849 for Type C-3 pipe. The inside diameter after lining shall not be less

than 98% of the nominal diameter of the pipe. The pipe, tees, and elbows before coating shall meet the requirements of Article 1032-3.

(G) Acceptance

Acceptance of coated, paved, and lined corrugated steel culvert pipe, and its accessories will be based on, but not limited to, visual inspections, classification requirements, check samples taken from material delivered to the project, and conformance to the annual Brand Registration.

Culvert pipe materials not meeting the above requirements will be rejected, unless written approval is obtained from the State Materials Engineer.

1032-5 CORRUGATED STEEL STRUCTURAL PLATE PIPE AND PIPE ARCH

The plate and fasteners for corrugated steel structural plate pipe and pipe arch shall meet the requirements of AASHTO M167.

When elongated pipe is called for by the contract, shop form the pipe to provide for a 5 percent elongation.

Unless otherwise required by the contract, place bolt holes along those edges of the plates that form longitudinal seams in the finished structure in 2 rows spaced 2" apart. Space the bolt holes a maximum of 6" apart.

Space bolt holes along those edges of the plates that form circumferential seams in the finished structure a maximum of 12" apart.

The minimum distance from the center of any bolt hole to the edge of the plate shall not be less than 1 3/4 times the diameter of the bolt. The diameter of bolt holes in longitudinal seams, excepting those at plate corners, shall not exceed the bolt diameter by more than 1/8". The diameter of holes in circumferential seams, including those at plate corners, shall not exceed the bolt diameter by more than 1/2" and the average of the diameter on the major and minor axes shall not exceed the bolt diameter by more than 1/4".

Cut plates for forming skewed or sloped ends to give the required angle of skew or slope. Burned edges shall be free from oxide and burrs and present a workmanlike finish. Repair damaged spelter coating around cut or burned edges as required by AASHTO M36.

Furnish an erection drawing for each installation. Mark each plate as necessary to insure proper placement in the structure.

Acceptance

Acceptance of corrugated steel structural plate pipe and pipe arches, and its accessories will be based on, but not limited to, visual inspections, classification requirements, check samples taken from material delivered to the project, and conformance to the annual Brand Registration. Culvert pipe materials not meeting the above requirements will be rejected unless written approval is obtained from the State Materials Engineer.

1032-6 CORRUGATED ALUMINUM ALLOY STRUCTURAL PLATE PIPE AND PIPE ARCH

The plate and fasteners for corrugated aluminum alloy structural plate pipe and pipe arch shall meet the requirements of AASHTO M219.

When elongated pipe is called for by the contract, shop form the pipe to provide for a 5 percent elongation.

Unless otherwise required by the contract, bolt holes along the plate edges that will form longitudinal seams in the finished structure shall be in 2 rows 1 3/4" apart and located in the valley end in the crest of each corrugation.

The minimum distance from the center of bolt holes to edge of plates shall not be less than 1 3/4 times the bolt diameter. Space bolt holes along those edges of the plates that form circumferential seams in the finished structure a maximum of 10" apart.

The diameter of bolt holes in longitudinal seams, excepting those at plate corners, shall not exceed the bolt diameter by more than 1/8". The diameter of holes in circumferential seams, including those at plate corners, shall not exceed the bolt diameter by more than 1/2" and the average of the diameters on the major and minor axes shall not exceed the bolt diameter by more than 1/4".

Accurately cut plates for forming skewed or beveled ends of structures to form the required final shape. Plates shall be saw cut, not burned, to present a competent finish free from notches or gouges.

Furnish an erection drawing for each installation. Mark each plate as necessary to insure proper placement in the structure.

Acceptance

Acceptance of corrugated aluminum alloy structural plate pipe and pipe arches, and its accessories will be based on, but not limited to, visual inspections, classification requirements, check samples taken from material delivered to the project, and conformance to the annual Brand Registration.

Culvert pipe materials not meeting the above requirements will be rejected unless written approval is obtained from the State Materials Engineer.

1032-7 VITRIFIED CLAY CULVERT PIPE

Vitrified clay culvert pipe shall meet the requirements of AASHTO M65 for extra-strength clay pipe.

When vitrified clay pipe sections have been inspected and accepted they will be stamped with the Department seal of approval. Do not use any pipe section that does not have this seal of approval.

Joint material shall meet the requirements of Subarticle 1028-8.

1032-8 WELDED STEEL PIPE

(A) Welded steel pipe shall meet the requirements of ASTM A139 for the grade of pipe called for on the plans.

(B) Acceptance

Acceptance of welded steel culvert pipe, and its accessories will be based on, but not limited to, visual inspections, classification requirements, check samples taken from material delivered to the project, and conformance to the annual Brand Registration.

Culvert pipe materials not meeting the above requirements will be rejected, unless written approval is obtained from the State Materials Engineer.

1032-9 CONCRETE CULVERT PIPE

(A) General

Use concrete pipe from sources participating in the Department's Concrete Pipe Quality Control/Quality Assurance Program. A list of participating sources is available from the Materials and Tests Unit's Central Laboratory**.** The Department will remove a manufacturer of concrete pipe from this program in the event that the monitoring efforts indicated that non-specification material is being provided or testings procedures are not being followed.

(B) Plain Concrete Culvert Pipe

Plain concrete culvert pipe shall meet all applicable requirements of AASHTO M170 except as follows:

(1) Do not reinforce it.

(2) The maximum weighted average loss for both coarse and fine aggregates is 15% when subjected to 5 cycles of the soundness test.

(3) The maximum percentage of wear for coarse aggregates is 55%.

Plain concrete culvert pipe shall meet the minimum requirements for Class II Wall A pipe except that the D-load to produce the ultimate load shall be 1,000 pounds.

(C) Reinforced Concrete Culvert Pipe

Reinforced concrete culvert pipe shall meet the requirements of AASHTO M170 for the class of pipe called for on the plans except as follows:

(1) The permissible wall thickness outside of the joint configuration shall not be more than that shown in the design by more than 5% or 3/16", whichever is greater.

(2) The maximum weighted average loss for both fine and coarse aggregates shall be 15% when subjected to 5 cycles of the soundness test.

(3) The maximum percentage of wear for coarse aggregates is 55%.

The design wall thickness shall be either the wall thickness shown in AASHTO M170 for the applicable class and wall or the wall thickness shown in a modified design that has been approved by the Engineer. A wall thickness greater than permitted by the above tolerance will be cause for rejection of the pipe. The circumferential steel in single cage pipe shall not be more than 3" from either end of the pipe section excluding the tongue and groove. On double cage pipe, extend one cage into the tongue or groove. Place the other cage so that a circumferential wire shall be not less than 2" from the other end of the barrel of the pipe.

(D) Precast Concrete Pipe End Sections

Precast concrete pipe end sections shall meet all applicable requirements of AASHTO M170 and Section 1077 except those pertaining to design.

Design concrete pipe end sections in accordance with the plans, or with plans prepared by the manufacturer which have been approved by the Engineer. Reinforce all concrete pipe end sections. Use air entrained concrete in pipe end sections, which attains a strength of 3500 psi when tested in accordance with AASHTO T22.

(E) Concrete Pipe Tees and Elbows

Concrete pipe tees and elbows shall meet all applicable requirements of AASHTO M170 for the class of pipe tee or elbow called for on the plans.

(F) Marking:

Clearly etchmark the following information on the outside of each section of pipe, pipe end section, tee, and elbow:

Pipe class and type of wall if reinforced

The date of manufacture(3)Name or trademark of the manufacturer

Clearly stamp, stencil, sticker or paint the following information on each section of pipe, pipe end section, tee and elbow

The State assigned plant number

The inside diameter of the pipe product

The year of manufacture

This marking shall be in the following format: State plant number - diameter - year. (CP99-24-06)

When concrete pipe, pipe end sections, tees, and elbows have been inspected and accepted they will be stamped with the Department seal of approval. Do not use pipe sections, pipe end sections, tees, or elbows which do not have this seal of approval. Failure of as much as 20 percent of any lot of pipe due to cracks, fractures, variation in alignment, or other manufacturing defects will be cause for the rejection of the entire lot. The lots shall be as designated by the manufacturer prior to inspection. Individual lengths of pipe within the lot which were not specifically rejected but

which are considered acceptable by the manufacturer may be removed from the rejected lot and resubmitted for inspection as a separate lot.

(G) Joint Materials

Cement shall meet the requirements of Article 1024-1. Sand shall meet the requirements of Article 1014-1 for fine aggregate or Article 1040-6 for mortar sand. Hydrated lime shall meet the requirements of Article 1040-5.

Flexible plastic joint material shall meet the requirements of AASHTO M198 for Type B flexible plastic gaskets, except as follows:

(1) The flash point, C.O.C. shall be a minimum of 325°F.

(2) The fire point, C.O.C. shall be a minimum of 350°F

1032-10 CORRUGATED POLYETHYLENE CULVERT PIPE

(A) General

Use corrugated polyethylene pipe from sources participating in the Department's HDPE Pipe Quality Control/Quality (QC/QA) Assurance Program. A list of participating sources is available from the Materials and Tests Unit's Central Laboratory. The Department will remove a manufacturer of polyethylene pipe from this program in the event that the monitoring efforts indicated that non-specification material is being provided or test procedures are not being followed.

Corrugated polyethylene culvert pipe shall meet the requirements of AASHTO M294 for Type S or Type D.

(B) End Treatments, Pipe Tees and Elbows

End treatments, pipe tees and elbows shall meet all applicable requirements of AASHTO M294, Section 7.8.

(C) Marking

Clearly mark each section of pipe, end section, tee, and elbow and other accessories according to the Department's HDPE Pipe QC/QA Program:

(1) AASHTO designation

(2) The date of manufacture

(3) Name or trademark of the manufacturer

When polyethylene pipe, end sections, tees, and elbows have been inspected and accepted they will be stamped with the Department seal of approval. Do not use pipe sections, flared end sections, tees, or elbows which do not have this seal of approval.

SECTION 1034
SANITARY SEWER PIPE AND FITTINGS

1034- 1 CLAY PIPE

Use extra strength vitrified clay sewer pipe conforming to ASTM C 700. Manufacture all joints and seals in accordance with ASTM C 425.

1034-2 POLYVINYL CHLORIDE (PVC) PLASTIC PIPE

(A) Gravity Flow Sewer Pipe

Use PVC plastic pipe that conforms to the requirements of ASTM D 3034 with a minimum SDR of 35. Use pipe with push-on type joints having bells made as an integral part of the pipe conforming to ASTM D 3212.

(B) Force Main Sewer Pipe

Pressure Rated Pipe:

Use PVC pipe conforming to ASTM D 2241 with a minimum SDR of 21 and minimum pressure rating of 200 psi. Use pipe with push-on type joints having bells made as an integral part of the pipe conforming to ASTM D 3139.

Pressure Class Pipe:

Use PVC pipe conforming to ANSI/AWWA C900 with a minimum DR of 18 and a minimum pressure class of 150 psi. Use pipe with push-on type joints having bells made as an integral part of the pipe conforming to ASTM D 3139.

1034- 3 CONCRETE SEWER PIPE

Use reinforced concrete sewer pipe conforming to ASTM C 76 or AASHTO M-170 with a Class III minimum rating. Use pipe with gasket joints conforming to ASTM C 443 or AASHTO M-198 type A or B.

1034- 4 DUCTILE IRON PIPE

(A) Gravity Flow Sewer Pipe

Use ductile iron pipe that conforms to ASTM A 746 or ANSI/AWWA C151/A21.51.

Use ductile iron pipe fittings and specials conforming to
ANSI/AWWA C110/A21.10 for standard size fittings or
ANSI/AWWA C153/A21.53 for compact fittings

Use pipe and fittings with push-on joints conforming to ANSI/AWWA C111/A21.11.

(B) Force Main Sewer Pipe:

Use ductile iron pipe that conforms to ANSI/AWWA C151/A21.51.

Use ductile iron pipe fittings and specials conforming to
ANSI/AWWA C110/A21.10 for standard size fittings or

ANSI/AWWA C153/A21.53 for compact fittings. Manufacture fittings with a cement mortar lining and a seal coat in accordance with ANSI/AWWA C104/A21.4.

Use pipe and fittings with either mechanical joints or push-on joints conforming to ANSI/AWWA C111/A21.11. When required or necessary, use approved type joint restraint devices with a minimum working pressure rating of 200 psi and a factor of safety of 2.

1034- 5 ACRYLONITRILE-BUTADIENE-STYRENE (ABS) PIPE

Acrylonitrile-butadiene-styrene (ABS) truss pipe shall meet the requirements of ASTM D2680. Provide joints for (ABS) truss sewer pipe that are of the extra-tight solvent welded joint type conforming to ASTM D2680.

Use ABS solid wall lateral sewer pipe for diameter of 4" to 6" that conforms to ASTM D2751 and is of sufficient wall thickness and strength to withstand the various earth and impact loads that bear on the installed pipe. Provide pipe that is circular in shape with no appreciable distortion and conforms to ASTM D2751. Provide joints for (ABS) solid wall lateral sewer pipe that are of the extra-tight solvent welded joint type conforming to ASTM D2751.

SECTION 1036
WATER PIPE AND FITTINGS

General

All materials when used to convey potable drinking water shall meet the requirements of the *National Sanitation Foundation Standard number 6*1.

1036- 1 COPPER PIPE

For indoor plumbing use copper pipe and sweated fittings conforming to ASTM B 88 for the type and temper called for in the plans and Specifications. Cast fittings for copper pipe shall meet the requirements of ASTM B 61 or ASTM B 62.

For buried service, use copper water pipe and tube conforming to ASTM B 88 soft annealed type K. Use flared or compression type fittings conforming to ANSI/AWWA C800 and local plumbing codes to connect pipe and tube.

1036-2 PLASTIC PIPE

(A) Polyvinyl Chloride (PVC) Pipe

Pressure Rated Pipe

Use PVC pipe conforming to ASTM D 2241 with a minimum SDR of 21 and minimum pressure rating of 200 psi. Use pipe with push-on type joints having bells made as an integral part of the pipe conforming to ASTM D 3139.

Pressure Class Pipe

Use PVC pipe conforming to ANSI/AWWA C900 with a minimum DR of 18 and a minimum pressure class of 150 psi. Use pipe with push-on type joints having bells made as an integral part of the pipe conforming to ASTM D 3139.

(B) Polyethylene (PE) Pipe

Use PE water pipe and tubing that conforms to AWWA C 901 with a minimum pressure class of 200 psi.

1036-3 BLANK

1036-4 STEEL PIPE

(A) Water Pipe

Use galvanized steel pipe meeting the requirements of ASTM A 53 for standard weight. Fittings for steel water pipe shall meet the requirements of ASTM A126 for Class B iron or of ASTM A197. Galvanize all fittings in accordance with ASTM A153.

(B) Encasement Pipe

Use steel pipe meeting an ASTM specification with the minimum yield strength of 35,000 psi. Use pipe that is circular in shape and straight in length.

1036-5 DUCTILE IRON PIPE AND FITTINGS

Use ductile iron pipe that conforms to ANSI/AWWA C151/A21.51.

Use ductile iron pipe fittings and specials conforming to ANSI/AWWA C110/A21.10 for standard size fittings or ANSI/AWWA C153/A21.53 for compact fittings. Manufacture fittings with a cement mortar lining and a seal coat in accordance with ANSI/AWWA C104/A21.4.

Use either mechanical joints or push-on joints conforming to ANSI/AWWA C111/A21.11. When required or necessary, use approved type joint restraint devices with a minimum working pressure rating of 200 psi and a factor of safety of 2.

1036-6 FIRE HYDRANTS

Use dry barrel type fire hydrants conforming to ANSI/AWWA C502 with a minimum 4-1/2" diameter valve opening with a 6" mechanical joint inlet connection, with two 2-1/2" hose connections and with one 4-1/2" pumper connection. Outlets shall have national standard fire hose coupling threads. Use a fire hydrant with a minimum bury length of 36". Securely chain nipple caps to the barrel. Paint hydrants with one coat of primer paint and two coats of an approved paint of the owner's standard color. Apply the final coat after hydrant installation.

1036-7 WATER VALVES.

(A) Gate Valves

Use iron body gate valves which conform to ANSI/AWWA C500 for bronze mounted, double disc, parallel seat type valves or to ANSI/AWWA C509 for resilient

seat type valves. For buried service use gate valves with non-rising stems, 2" square operating nuts, O-ring seals, and which open by turning counter clockwise. Gate valves shall have mechanical joint ends conforming to ANSI/AWWA C111/A21.11. Gate valves shall have a design working water pressure of 200 psi.

(B) Bronze Gate Valves

Use bronze gate valves conforming to ASTM B 62 with tee head operating nuts and solid wedges. Use valves with a design working pressure of 200 psi.

(C) Tapping Valves

Use tapping valves conforming to Section 1036-7A with appropriately sized openings, with flanged by mechanical joint ends, and pressure rated at 200 psi.

1036-8 SLEEVES, COUPLINGS, AND MISCELLANEOUS

(A) Tapping Sleeves

Use cast iron, ductile iron, or Type 304 stainless steel tapping sleeves pressure rated at 200 psi. Use either the split sleeve type with mechanical joint ends or the full circle type with double seals. Manufacture the outlet flange to mate with the tapping valve flange.

(B) Transition Sleeves and Couplings

Use sleeve type couplings for transitioning between plain ends of different pipe types. Manufacture couplings in conformance with ANSI/AWWA C219 for a rated working pressure of 200 psi. Coat the coupling at the factory with an epoxy in conformance with ANSI/AWWA C210 or ANSI/AWWA C213.

1036-9 SERVICE LINE VALVES AND FITTINGS

Use corporation stops and curb stops of all bronze material and high-pressure construction conforming to ANSI/AWWA C800.

Use tapping saddles of high-pressure construction, shaped to conform to the pipe, and in conformance with ANSI/AWWA C800.

Use high-pressure fittings manufactured in conformance with ANSI/AWWA C800.

SECTION 1040
MASONRY

1040-1 BRICK

Use clay or shale brick that meets the requirements of ASTM C62 for Grade SW, except as otherwise provided below.

Use brick of uniform standard commercial size, with straight and parallel edges and square corners that are burned hard and entirely true, free from injurious cracks and flaws,

tough, strong, and have a clear ring when struck together. The sides, ends, and faces of all brick shall be plane surfaces at right angles and parallel to each other.

Brick of the same manufacturer shall not vary more than plus or minus 1/16" in thickness, plus or minus 1/8" in width, and plus or minus 1/4" in length.

Concrete brick may be used in lieu of clay or shale brick when designated on the plans or in the specifications. Concrete brick shall meet the requirements of ASTM C55 for Grade S-II except that the absorption of brick used in minor drainage structures shall not exceed 10 lbs./ft.^{3}.

1040-2 CONCRETE BUILDING BLOCK

Use concrete building block from sources that participate in the Department's Solid Concrete Masonry Brick/Unit Quality Control/Quality Assurance Program. A list of these sources in North Carolina and adjoining states is available from the Materials and Tests Unit in Raleigh.

Use concrete building block that meets the requirements of ASTM C90 for Type II. Block is pink in color and is to be substantially free from chips and cracks.

Solid concrete block to be used in lieu of clay brick for minor drainage structures shall meet the requirements of ASTM C139 except that the nominal dimensions shall be 4" x 8" x 16".

Concrete block for block manholes shall meet the requirements of ASTM C139.

1040-3 CONCRETE PAVING BLOCK

Use concrete building block from sources that participate in the Department's Solid Concrete Masonry Brick/Unit Quality Control/Quality Assurance Program. A list of these sources in North Carolina and adjoining states is available from the Department's Laboratory in Raleigh.

Concrete paving block shall be solid concrete block and meet the requirements of ASTM C139 except that the nominal dimensions shall be 4" x 8" x 16". The block shall have a uniform surface color and texture.

1040-4 CEMENT

Portland cement shall meet the requirements of Article 1024-1.

Masonry cement shall meet the requirements of ASTM C91.

1040-5 HYDRATED LIME

Hydrated lime shall meet the requirements of ASTM C207 for Type N.

1040-6 MORTAR SAND

Mortar sand shall meet the requirements of Article 1014-1, except that it shall meet the gradation requirements for No. 4S sand shown in Table 1005-2.

1040-7 WATER

Water shall meet the requirements of Article 1024-4.

1040-8 MORTAR

Mortar used in all brick masonry and block masonry shall be proportioned as shown below for either mix No. 1 or No. 2. All proportions are by volume. Do not add any more water than is necessary to make a workable mixture.

Mix No. 1: 1 part portland cement
1/4 part hydrated lime
3 3/4 parts mortar sand (maximum)

Mix No. 2: 1 part portland cement
1 part masonry cement
6 parts mortar sand (maximum)

The requirements of Articles 1040-4, 1040-5, 1040-6, and 1040-7, are applicable to all cement, hydrated lime, mortar sand, and water.

For the hydrated lime and cement portion of Mix No. 1,the Contractor may substitute Type M or Type S masonry cement that meets ASTM C270 For Type S masonry cement the minimum compressive strength of the test specimens shall be 2500 psi at 28 days and the test specimens shall be composed of 1 part Type S masonry cement and 3 parts sand. Furnish a Type 3 certification for the Type M or Type S masonry cement.

1040-9 CEMENT GROUT

Use cement grout that consists of a mixture of 1 part portland cement to 3 parts mortar sand with no more water than is necessary to make a workable mixture.

Apply the requirements of Article 1040-4, 1040-6, and 1040-7 to all cement, mortar sand, and water.

SECTION 1042
RIPRAP MATERIALS

1042-1 PLAIN RIPRAP

Stone for plain riprap consists of field stone or rough unhewn quarry stone. The stone shall be sound, tough, dense, resistant to the action of air and water, and suitable in all other respects for the purpose intended. Where broken concrete from demolished structures or pavement is available, it may be used in place of stone provided that such use meets with the approval of the Engineer. However, the use of broken concrete that contains reinforcing steel will not be permitted.

All stone shall meet the approval of the Engineer. While no specific gradation is required, there should be equal distribution of the various sizes of the stone within the

required size range. The size of an individual stone particle will be determined by measuring its long dimension.

Stone or broken concrete for riprap shall meet the requirements of Table 1042-1 for the class and size distribution.

TABLE 1042-1
ACCEPTANCE CRITERIA FOR RIPRAP
AND STONE FOR EROSION CONTROL

	REQUIRED STONE SIZES – INCHES		
CLASS	**MINIMUM**	**MIDRANGE**	**MAXIMUM**
A	2	4	6
B	5	8	12
1	5	10	17
2	9	14	23r

No more than 5.0% of the material furnished can be less than the minimum size specified nor no more than 10.0% of the material can exceed the maximum size specified.

1042-2 TESTING

Test riprap materials in accordance with the requirements of this section and Sections 1005-4(E) Resistance to Abrasion, and 1005-4(F) Soundness. Satisfactory resistance to abrasion will be considered to be a percentage of wear of not greater than 55 percent. Satisfactory soundness will be considered to be a loss in weight of not greater than 15 percent when subjected to 5 alterations of the soundness test.

SECTION 1044
SUBSURFACE DRAINAGE MATERIALS

1044-1 SUBDRAIN FINE AGGREGATE

The subdrain fine aggregate shall meet the gradation requirements for No. 2S or No. 2MS sand as shown in Table 1005-2.

1044-2 PIPE AND FITTINGS--GENERAL

Pipe and fittings may be, at the option of the Contractor, either concrete, corrugated steel, bituminized fiber, or corrugated plastic.

1044-3 CONCRETE PIPE AND FITTINGS

Non-perforated concrete pipe and pipe fittings shall meet the requirements of AASHTO M86 for standard strength nonreinforced concrete pipe.

Perforated concrete pipe shall meet the requirements of AASHTO M175 for standard strength perforated nonreinforced concrete underdrainage pipe.

Joint materials shall meet the requirements of Section 1028.

1044-4 CORRUGATED STEEL PIPE AND FITTINGS

Non-perforated corrugated steel pipe and pipe fittings shall meet the requirements of Subarticle 1032-3(A).

Perforated corrugated steel pipe shall meet the requirements of AASHTO M36.

Fabricate the corrugated steel pipe from steel sheets having a minimum thickness of 0.052".

1044-5 POLYVINYL CHLORIDE PLASTIC PIPE

Polyvinyl chloride plastic pipe shall meet the requirements of ASTM D1785.

1044-6 CORRUGATED PLASTIC PIPE AND FITTINGS

Corrugated plastic pipe and fittings shall meet the requirements of AASHTO M252 for heavy duty tubing, except that the maximum stretch resistance shall be 10 percent.

1044-7 OUTLET PIPE

Outlets constructed of PVC Schedule 40 pipe shall meet the requirements of ASTM D 2665. HDPE pipe shall meet the requirements of AASHTO M-294, Type S.

SECTION 1046
GUARDRAIL MATERIALS

1046-1 GENERAL

Use guardrail materials from sources meeting requirements of the Department's Brand Certification Program for guardrail. A list of these sources is available from the Materials and Test Unit's Central Laboratory. The Department will remove a manufacturer of guardrail materials from this program in the event that the monitoring efforts indicated that non-specification material is being provided or test procedures are not being followed.

The following types of guardrail materials and all associated accessories may be accepted under this program.

Rail elements.
Posts and offset blocks
Terminal sections
Anchor units
Transition sections
Hardware

1046-2 RAIL ELEMENTS

The rail element and terminal sections shall meet the requirements of AASHTO M180 for Class A, Type 2.

1046-3 POSTS AND OFFSET BLOCKS

(A) General

The Contractor may, at his option, furnish any one of the following types of steel guardrail posts. Only one type of post will be permitted at any one continuous installation. Use structural steel posts throughout the project, unless otherwise directed or detailed in the plans.

(1). Steel W6 x 8.5 or W6 x 9.0 posts.

(2) Steel 4.5" x 6.0" "C" shape posts.

The Contractor may at his option furnish either of the following types of treated timber posts if specifically directed or detailed in the plans. Only one type of post will be permitted at any one continuous installation.

(1) Timber 6" x 8" posts

(2) Timber 8" x 8" posts

(B) Structural Steel Posts

Fabricate steel posts for guardrail of the size and weight shown on the plans from structural steel complying with the requirements of Section 1072. Metal from which C shape posts are fabricated shall meet the requirements of ASTM A570 for any grade of steel except that mechanical requirements that shall meet the requirements of ASTM A36. Punch or drill the holes for connecting bolts. Burning will not be permitted. After fabrication the posts shall be galvanized in accordance with Section 1076.

(C) Treated Timber Posts

Timber guardrail posts shall be of treated southern pine meeting the requirements of Article 1082-2 and 1082-3.

Bore bolt holes to a driving fit for the bolts. A minus tolerance of 1 percent will be allowed in the length of the post. Perform all framing and boring before the posts receive preservative treatment.

(D) Offset Blocks

Provide 8" deep recycled plastic or composite offset blocks that have been approved for use with the guardrail shown in the standard drawings and/or plans. Only one type of offset block will be permitted at any one continuous installation. Prior to beginning the installation of recycled offset block, submit the FHWA acceptance letter for each type of block to the Engineer for approval.

Treated timber offset blocks with steel beam guardrail will not be allowed unless required by Specifications, directed by the Engineer or detailed in the plans. Steel offset blocks with steel beam guardrail will not be allowed.

Recycled plastic or composite offset blocks shall be made from no less than 50% recycled plastic or composite and shall meet the following minimum requirements:

Specific Gravity:.....0.950
Compressive Strength in Lateral Direction:..1600 psi
Maximum Water Absorption:.....10% by weight

Maximum Termite and Ant Infestation:	10%
Testing:	Shall pass NCHRP Report 350, Test Level 3 by CRASH TESTING
Approval:	Shall be approved for use by the FHWA

1046-4 HARDWARE

Provide all hardware as indicated on the plans that is galvanized in accordance with ASTM A153.

1046-5 ANCHORS AND ANCHOR ASSEMBLIES

Each shipment of guardrail terminal end sections, anchors and anchor assemblies shall be shipped from the manufacture with a current parts list and installation guide. Units not having the above documents will be rejected.

The requirements of Articles 1046-1, 1046-2, and 1046-3 are applicable to rail elements, terminal sections, posts, offset blocks, and hardware.

Reinforcing steel shall meet the requirements of Article 1070-2. Steel plates shall meet the requirements of ASTM A36. Anchor rods shall meet the requirements of ASTM A663 for Grade 65.

Anchor cable shall be 3/4" wire rope having a minimum breaking strength of 21.4 tons and galvanized. Use commercial quality galvanized steel cable thimbles. Use commercial quality drop forged galvanized steel cable clips. The fitting and stud for the anchor cable shall be suitable for cold swaging and be galvanized. After being swaged on the cable, the fitting and stud assembly, including swaged joint and cable, shall have a minimum breaking strength of 21.4 tons.

Perform welding in accordance with Article 1072-20.

Welded components shall be galvanized after welding in accordance with ASTM A123. All other metal parts shall be galvanized in accordance with ASTM A153, except where otherwise specified in Articles 1046-1, 1046-2, and 1046-3.

1046-6 REPAIR OF GALVANIZING

Perform repair of galvanizing in accordance with Section 1087-6.

1046-7 CABLE GUIDERAIL

Posts, hardware, and miscellaneous components shall meet the applicable requirements of this Section, the plans and the manufacture's requirements.

Furnish Cable guiderail manufactured in accordance with AASHTO M-30, Type 1, Class A.

For concrete anchors, furnish Class A concrete if cast in place; or use concrete meeting the requirements of Section 1077 if using precast concrete anchors.

Cable guiderail is not covered under the Brand Certification Program for guardrail materials. Sample cable guiderail according to Minimum Sampling Guide.

1046-8 ACCEPTANCE

Acceptance of guiderail materials and its accessories will be based on, but not limited to, visual inspections, classification requirements, check samples taken from material delivered to the project, and conformance to the annual Brand Registration.

Guiderail materials not meeting the above requirements will be rejected, unless written approval is obtained from the State Materials Engineer.

SECTION 1050
FENCE MATERIALS

1050-1 GENERAL

(A) Chain Link Fence

The Contractor may, at his option, furnish either a galvanized steel fence framework or an aluminum alloy fence framework unless otherwise specified in the contract.

Where a galvanized steel framework is used, the fence fabric may be either galvanized steel or aluminum coated steel, except where galvanized steel fabric is specified in the contract. The Contractor may, at his option, furnish any of the following galvanized steel framework systems:

SYSTEM G1

Line Posts	Steel Pipe
Terminal Posts (End, Corner, or Brace Posts)	Steel Pipe
Gate Posts, Double Gate	Steel Pipe
Gate Posts, Single Gate	Steel Pipe
*Brace Rail and Top Rail	Steel Pipe

SYSTEM G2

Line Posts	Steel H Post
Terminal Posts (End, Corner, Or Brace Posts)	Steel Pipe
Gate Posts, Double Gate	Steel Pipe
Gate Posts, Single Gate	Steel Pipe
*Brace Rail and Top Rail	Steel Pipe

SYSTEM G3

Line Posts	Roll Formed Steel
Terminal Posts (End, Corner, or Brace Posts)	Steel Pipe
Gate Posts, Double Gate	Steel Pipe
Gate Posts, Single Gate	Steel Pipe
*Brace Rail and Top Rail	Steel Pipe or Roll Formed Pipe

* Top rail to be used in lieu of tension wire only where called for in the itemized proposal.

Where an aluminum alloy framework is used, the fence fabric may be either aluminum alloy or aluminum coated steel. The Contractor may, at his option, furnish any of the following aluminum alloy framework systems:

SYSTEM A1

Line Posts	Aluminum Pipe
Terminal Posts (End, Corner, or Brace posts)	Aluminum Pipe
Gate Posts, Double Gate	Aluminum Pipe
Gate Posts, Single Gate	Aluminum Pipe
*Brace Rail and Top Rail	Aluminum Pipe

SYSTEM A2

Line Posts	Aluminum H Post
Terminal Posts (End, Corner, or Brace Posts)	Aluminum Pipe
Gate Posts, Double Gate	Aluminum Pipe
Gate Posts, Single Gate	Aluminum Pipe
*Brace Rail and Top Rail	Aluminum Pipe

*Top rail to be used in lieu of tension wire only where called for in the itemized proposal.

Use the same type of fabric and framework materials throughout the project.

(B) Wire Gage

Whenever the term *gage* is used in this section to refer to a size of wire, it will be construed to mean the United States Steel Wire Gage regardless of whether or not the base metal of the wire is steel or a nonferrous metal.

1050-2 TIMBER POSTS AND BRACES

(A) General

All timber posts and braces shall be of treated southern pine meeting the requirements of Article 1082-2 and 1082-3, except as otherwise specified herein. Posts and braces may be either round or square, at the option of the Contractor, provided that the same shape is used throughout the project for both the posts and the braces. Post and brace sizes are shown on the plans in inches. The size refers to the diameter for round pieces, or to the edge dimension for square pieces. Square posts and braces shall be fully dressed S4S. An allowable tolerance of 1/2" scant for square pieces will be permitted from the dimensions called for on the plans.

Cut round wood posts and braces from sound solid trees, free from short or reverse bends in more than 1 plane. Do not use log veneer cores for posts and braces unless they contain at least one inch of Sapwood for their entire circumference on both ends. The post or brace shall not deviate more than 1" at any point from a straightedge held longitudinally against the piece.

All posts shall be free from ring shake, season cracks more than 1/4" wide, splits in the ends, and contain no unsound knots. Sound knots will be permitted provided the width of the knot does not exceed 1/3 the diameter of the post where it occurs. Groups of knots or any combination of defects that will impair the strength of the piece will not be permitted. The pieces shall show not less than 3 annual rings per inch and not less than 30 percent of summer wood.

A tolerance of 1" plus and 1/2" minus will be allowed for the diameter of round posts and braces, measured at the small end after peeling. Where they are out of round, this tolerance will apply to the smaller diameter, and the larger diameter shall not exceed the smaller by more than 20 percent. The maximum rate of increase in diameter at the butt shall be 1 1/2" in 10 feet.

A minus tolerance of 1 percent will be allowed in the length of both round and square posts. Cut the ends square.

(B) Optional Steel Posts and Braces

The Contractor will be permitted to use steel posts and braces for woven wire fence in lieu of timber posts and braces in those areas of the State located in or west of Vance, Franklin, Wake, Lee, Moore, and Richmond Counties. Use the same type of fence post and brace throughout the project. The optional steel posts and braces shall meet the requirements of Subarticle 1050-3(B).

1050-3 METAL POSTS AND RAILS

(A) Chain Link Fence

Posts shall meet the requirements of AASHTO M 181 except as otherwise provided by this subarticle.

Steel H posts shall have a minimum yield strength of 45,000 psi and weigh 3.26 pounds per foot. Galvanize steel H posts in accordance with ASTM F 1043 with a Type A coating. Aluminum H posts shall weigh 1.25 pounds per foot.

Roll formed steel line posts shall be a 1.625" x 1.875" section weighing 2.40 lb./lf. after galvanizing and be formed from 0.121" thick sheet having a minimum yield strength of 45,000 psi. Roll formed steel brace rails and top rails shall be a 1.250" x 1.625" section weighing 1.35 lb./lf. after galvanizing and be formed from 0.080" thick sheet steel having a minimum yield strength of 45,000 psi. Galvanize all roll formed members after fabrication in accordance with ASTM F 1043 with a Type A coating.

Vinyl coated posts shall be pipe posts meeting the requirements of AASHTO M 181, and have a fusion bonded vinyl coating at least 6 mils thick. The vinyl shall meet the requirements of Section 6 of AASHTO M 181 or if a standard color not listed in M 181 is used, the vinyl shall meet the color requirements in ASTM F 934 Table 1.

Furnish brace rails with suitable metal connections to fasten them securely to the posts. Provide the top rail not less than 6" long with a minimum thickness of 0.051" if steel, or 0.062", 6063-T6 aluminum alloy and in minimum lengths of 15 feet. The complete top rail assembly shall form a continuous rail passing through the top fittings of the line posts and be furnished with suitable metal connections to fasten it to the posts at each end.

For pipe 1.90” O.D. and under, the outside diameter at any point shall not vary more than 1/64” over no more than 1/32” under the standard specified. For pipe 2.375”O.D. and over, the outside diameter shall not vary more than ±1% from the

standard specified nor shall the minimum wall thickness at any point be more tan 12.5% under the nominal wall thickness specified.

A 10% minimum weight tolerance will be allowed for all steel posts and rails.

(B) Woven Wire Fence

Steel posts used in lieu of 4" timber posts shall be a standard studded T section 7'-6" long designed exclusively for use as a fence post and be equipped with a metal anchor plate securely attached to the post. The T posts shall weigh 1.33 lb. per linear foot exclusive of the weight of the anchor plate, and have a total weight, including anchor plate, of 10.65 lb. Nominal dimensions of the T post shall be 1 3/8 " wide and 1 3/8" deep. A tolerance of plus or minus 3/16" will be permitted from these nominal dimensions. The anchor plate shall be sufficiently sturdy to withstand the strain of driving with no loss of effectiveness, and have a minimum area of 14.0 square inches.

Steel posts used in lieu of 5" timber posts may be either tubular posts or angle posts. They shall be 8'-0" long and be embedded in a concrete anchor at least 3'-3" deep and 10" in diameter. Fit tubular posts with ornamental tops that fit over the top of the post to cap against moisture. Fabricate the tubular posts from 2" diameter pipe meeting the requirements of AASHTO M 181 for Grades 1 or 2 metallic coated posts and rails. Fabricate angle posts from angle sections measuring 2 1/2"x 2 1/2"x 1/4", with a plus or minus tolerance of 1/16" on the 2 1/2" dimension and 0.015" on the 1/4" dimension, and weighing 4.10 lbs. per foot.

Use steel braces with steel posts and may be either tubular braces or angle braces to match the posts. Furnish the braces with suitable metal connections to fasten them securely to the posts. Fabricate tubular braces from 1 1/4" diameter pipe meeting the requirements of AASHTO M 181 for Grades 1 or 2 metallic coated posts and rails. Fabricate angle braces from angle sections measuring 2" x 2" x 1/4" with a plus or minus tolerance of 3/64" on the 2" dimension and 0.010" on the 1/4" dimension, and weighing 3.19 lbs. per foot.

A 10% minimum weight tolerance will be allowed for all steel posts and braces.

For pipe 1.90” O.D. and under, the outside diameter at any point shall not vary more than 1/64” over no more than 1/32” under the standard specified. For pipe 2.375” O.D. and over, the outside diameter shall not vary more than ±1% from the standard specified nor shall the minimum wall thickness at any point be more than 12.5% under the nominal wall thickness specified.

Galvanize all steel posts and braces other than tubular members in accordance with the requirements of ASTM A 123.

1050-4 BARBED WIRE

Barbed wire shall meet the requirements of ASTM A 121 except as otherwise provided in this subarticle.

The barbed wire may be, at the option of the Contractor, either galvanized steel or aluminum coated steel except that where aluminum chain-link fabric is used, galvanized

steel barbed wire shall not be used. Use the same type of material throughout the project. All barbed wire shall have 4 point barbs spaced not more than 5" apart. Single strand barbed wire will not be acceptable.

Two strand galvanized steel barbed wire shall be fabricated from either 12 1/2 gage or 15 1/2 gage strand wire with 4 point galvanized steel 14 gage barbs. The 12 1/2 gage shall be Standard Grade with a Class 3 coating on the wire and a Class 1 coating on the barbs. The 15 1/2 gage shall be Chain Link Fence Grade with a Class 3 coating on both the wire and barbs.

Two strand aluminum coated steel barbed wire shall be fabricated from two strands of 12 1/2 gage aluminum coated steel wire with the four point barbs being either 14 gage aluminum coated steel or aluminum alloy wire.

1050-5 WOVEN WIRE

Woven wire fencing shall conform to ASTM A 116 or AASHTO M 279. The fence fabric shall be 47" high, with 10 horizontal strands. Space the strands 3" apart at the bottom and 8" apart at the top with progressive spacing between. Space vertical strands at 6" intervals. Any of the following styles and coating classes may be used.

(A) Style 1047-6-9, Grade 60 (all horizontal and vertical strands of wire shall be 9 gage) with a Class 3 zinc coating.

(B) Style 1047-6-11, Grade 60 (top and bottom horizontal strands to be 9 gage wire, all other strands to be 11 gage) with a Class 3 zinc coating.

(C) Style 1047-6-12 1/2, Grade 125 (top and bottom horizontal strands of wire to be no smaller than 10 1/2 gage with a minimum breaking strength of 1610 lb, all other strands to be no smaller than 12 1/2 gage with a minimum breaking strength requirement for horizontal strands of 960 lb with a Class 3 coating.

Brace wire shall be a 9 gage steel in accordance with ASTM A 641, except that the minimum zinc coating shall be 0.80 oz/ sq. ft.

TABLE 1050-1
WIRE DIAMETER

Size Coated Wire, Gage	Nominal Diameter of Zinc Coated Wire, In.
6	0.192
7	0.177
9	0.148
10 1/2	0.128
11	0.120
12	0.106
12 1/2	0.099

1050-6 CHAIN LINK FABRIC

Chain link fence fabrics shall meet the requirements of AASHTO M 181. Galvanized steel fabric shall have a Class D coating. Polyvinyl coated fabric shall be Type IV, Class A or B and the vinyl coating shall be a standard color meeting AASHTO M 181 or ASTM F 934 Table 1.

The height of the chain link fence fabrics shall be as shown in the pay item description. Weave the fabric from 11 gage wire, unless otherwise required by the contract.

1050-7 FITTINGS, HARDWARE AND ACCESSORIES

All fittings, hardware and accessories to be used with the fencing shall meet the requirements of AASHTO M 181, AASHTO M 232, ASTM F 626 OR ASTM A 641 or ASTM A 809 except for the size, type and coating requirement that shall be that shall be as shown below in Table 1050-2 and elsewhere in this article.

Galvanize bolts, nuts, washers, and other threaded items in accordance with AASHTO M 232.

Where shown on the plans, fit the posts with ornamental tops. The base of tops to be used with pipe posts shall fit over the top of the post to guard against moisture.

TABLE 1050-2

Item	Gage or diameter (inch)	Coating (oz/sq. ft)	Coating (oz/sq. ft^2 Aluminum)	Remarks:
Tie wires, steel	9	0.90	0.40	For fastening chain link fabric and tension wire to tubular sections or to roll formed steel line posts.
Tie wires, Aluminum	6	---	---	Alloy 1350-H19 or approved equal
Clips, steel wire	7	0.90	---	For fastening chain link fabric and tension wire to H- posts
Clips, steel wire	11	0.85	---	For fastening woven wire fabric to steel posts
Hog rings, steel	12	0.80	0.40	For fastening chain link fabric to tension wire
Hog rings, aluminum	9	---	---	Alloy 1350-H19 or approved equal.
Truss rod, steel	5/16	2.00	---	---
Tension (stretcher) bars, steel	3/16 x 3/4	1.50	---	For connection of 1 3/4 in or 2 in. fabric to end, gate, and corner posts for fabric heights over 5 ft
Tension (stretcher) bars, steel	3/16 x 5/8	1.50	---	For connection of 1 3/4 in or 2 in. fabric to end, gate, and corner posts for fabric heights UP TO 5 ft
Tension (stretcher) bars, steel	1/4 x 3/8	1.50	---	For connection of 1 in fabric to end, gate, and corner posts
Staples, Nails or	9	0.35	---	For fastening woven wire to timber posts. Shall be the size and shape shown on the plans.
Tension wire braces	9	0.90	0.40	For woven wire fence
Post and line caps	---	1.30	---	For installation on top of posts to guard against moisture.
Rail and brace ends (pressed steel or cast iron)	---	1.30	---	---
Top rail steel sleeves	0.051 in.	1.30	---	For rail connections. Shall be fabricated to prevent movement along the rail.
Tension band	14	1.30	---	For fastening tension bar to posts
Brace band	12	1.30	---	For fastening rail to posts
Barbed wire extension arms (pressed steel or cast iron)	14	1.30	---	Shall be fitted with clips or slots for attaching the barbed wire to the arms.
Hinges, latches	---	2.00	---	---

Tension wire for use with galvanized steel chain link fabric shall meet the requirements of AASHTO M 181 for zinc coated tension wire. Tension wire for use with aluminum or aluminum coated chain link fabric may be either aluminum coated tension wire meeting the requirements of AASHTO M 181, or solid aluminum wire with a minimum diameter of

0.192". The aluminum for solid aluminum wire shall meet the requirements of ASTM B 211 for alloy 5056 or 6061, and have a minimum breaking strength of 1216 lbf and a minimum elongation of 10%.

Vinyl coated fittings and accessories shall be galvanized steel or aluminum coated steel meeting the requirements of this article and have a bonded vinyl coating. The vinyl shall meet the requirements of Section 6 of AASHTO M 181 and be a standard color meeting AASHTO M 181 or ASTM F 934 Table 1. The vinyl coating shall be at least 6 mils thick, except that the coating on tension wire, hog rings, and tie wires shall be at least 20 mils thick.

1050-8 REPAIR OF GALVANIZING

Repair of galvanizing shall be in accordance with Section 1076-6. Do not use aerosol can products for repairs.

SECTION 1052
SALT AND LIME STABILIZERS

1052-1 SODIUM CHLORIDE

Sodium chloride shall meet the requirements of AASHTO M143.

1052-2 CALCIUM CHLORIDE

Calcium chloride shall be Class S or L meeting the requirements of AASHTO M144.

1052-3 LIME

(A) Chemical Requirements

Quicklime and hydrated lime for soil stabilization shall meet the requirements of ASTM C977 except that it shall contain a minimum of 86 percent available calcium oxide (CaO) on an LOI-free basis.

(B) Physical Requirements

(1) Hydrated Lime

Hydrated lime shall have a minimum of 85 percent passing a No. 200 sieve.

(2) Quicklime

Grade quicklime so that 100% passes a 1/4" sieve.

(C) Sampling and Inspection

Furnish Type 1 or Type 2 material certifications with each shipment of lime attesting that the lime meets the requirements of the Specifications; however, the material will be subject to inspection, test, or rejection by the Engineer at any time.

Lime from more than one source or more than one type may be used on the same project, but the different limes shall not be mixed. Protect the lime from exposure until used and sufficiently dry it to flow freely when handled.

SECTION 1054
MISCELLANEOUS MATERIALS

1054-1 RIGHT OF WAY MARKERS

(A) General

The Contractor may, at his option, use either granite right of way markers or concrete right of way markers.

(B) Concrete

Concrete right of way markers shall be constructed of concrete in accordance with the requirements of Section 1077. Reinforcement shall meet the requirements of Article 1070-2 for steel bar reinforcement.

Precast the right of way marker in watertight forms of a size and shape that will produce a completed marker of the dimensions shown on the plans. Construct the forms so as to impress the plastic concrete with the lettering and markings shown on the plans.

Cure the concrete in accordance with Article 420-16. Give that portion of the right of way marker that will be above the surface of the ground ordinary surface finish in accordance with Subarticle 420-18(B).

(C) Granite

Make granite right of way markers from granite that is hard and durable, of a light color, free from seams which impair its structural integrity, and of a good, smooth splitting appearance. Quarry and finish the markers to the dimensions indicated on the plans. Drill holes will be permitted in the sides and bottom.

1054-2 BLANK

1054-3 DECK DRAINS

Provide deck drains made of polyvinyl chloride plastic pipe or of steel pipe. Use the type of pipe as shown on the plans.

Polyvinyl chloride plastic pipe shall meet the requirements of ASTM D1785 or D2665, and have four 1/2" square lugs shop glued at approximately equal spacing around the pipe at 3" from the top end of each deck drain.

Steel pipe shall meet the requirements of ASTM A53 for standard weight galvanized pipe.

1054-4 FUNNELS AND FUNNEL DRAINS

(A) Funnels

Fabricate funnels for corrugated aluminum alloy pipe from clad aluminum alloy sheets meeting the requirements of AASHTO M196. Perform fabrication by riveting. The completed funnel shall meet all applicable requirements of AASHTO M196.

Fabricate funnels for corrugated steel pipe of steel meeting the applicable requirements of AASHTO M218. Fabrication may be by riveting or by welding. The completed funnel shall meet all applicable requirements of AASHTO M36.

(B) Funnel Drain Pipe, Elbows and Fittings

Funnel drain pipe, elbows, and other fittings may be, at the option of the Contractor, either corrugated aluminum alloy or corrugated steel.

Corrugated aluminum alloy pipe, elbows, and other fittings shall meet the requirements of Article 1032-2.

Corrugated steel pipe, elbows, and other fittings shall meet the requirements of Article 1032-3.

1054-5 SYNTHETIC ROVING

Use either fiberglass roving or polypropylene roving for synthetic roving.

Form fiberglass roving material from continuous fibers drawn from molten glass, coated with a chrome-complex sizing compound, collected into strands and lightly bound together into a roving without the use of a binding agent or other deleterious substance. Wind the roving into a cylindrical package so that the material can be continuously withdrawn from the center using a compressed air ejector so that the roving expands into a mat of glass fibers on the soil surface.

Form polypropylene roving material from continuous strands of fibrillated polypropylene yarn. Wind the roving onto cylindrical packages so that the roving can be continuously fed from the outside of the package through an ejector driven by compressed air and expanded into a mat of polypropylene strands. The product shall not contain agents toxic to plant or animal life.

Furnish a Type 3 Certification in accordance with Article 106-3 certifying that the fiberglass roving is an electrical grade material meeting the requirements shown in Table 1054-2.

TABLE 1054-1
FIBERGLASS ROVING PROPERTIES

Property	Limits	Test Methods
Strands/Rove	36-44	End Count
Fiber Diameter, in. (Trade Designation G)	0.00035-0.00045	ASTM D578

TABLE 1054-2
POLYPROPYLENE ROVING PROPERTIES

Property	Limits	Test Methods
Strands/Rove	20-30	End Count
Fiber Diameter, in. (Trade Designation G)	0.0094	Theoretical
Yards/lb. of Rove	515	ASTM D1907

1054-6 GROUT FOR CONCRETE ROADWAY TRAFFIC BARRIER

Use grout that is a commercially manufactured non-shrink, non-metallic material meeting the requirements of these Specifications when water or water and aggregate is added in accordance with the manufacturer's recommendations.

The grout shall be free of soluble chlorides and contain less than one percent soluble sulfate.

Initial setting time shall not be less than 10 minutes when tested in accordance with ASTM C266.

Compressive strength shall be at least 5000 psi at 3 days.

Compressive strength in the laboratory will be determined in accordance with ASTM C109 except that the test mix shall contain only water and the dry manufactured material. Compressive strength will be determined in the field by molding and testing 4" x 8" cylinders in accordance with AASHTO T22.

When tested in accordance with ASTM C666, Procedure A, the durability factor of the grout shall not be less than 80.

The quantity of water added to the mix shall be in accordance with the manufacturer's recommendations.

Aggregate may be added to the mix only where recommended or permitted by the manufacturer. The quantity and gradation of the aggregate will be in accordance with the manufacturer's recommendations.

Furnish a Type 4 material certification showing results of tests conducted to determine the properties listed in this Specification and to assure that the material is non-shrink.

The Engineer reserves the right to reject material based on unsatisfactory performance.

SECTION 1056
ENGINEERING FABRICS

1056-1 GENERAL

The fabric shall consist of strong rot-proof synthetic fibers formed into a woven fabric or a non-woven needle-punched fabric meeting all applicable requirements of this section.

The fabric shall be free from any treatment or coating that might significantly alter its physical properties before or after installation. The fabric fibers shall contain stabilizers and/or inhibitors to make the filaments resistant to deterioration resulting from ultraviolet or heat exposure. The fabric shall be a pervious sheet of synthetic fibers oriented into a stable network so that the fibers retain their relative position with respect to each other. Finish the edge of the fabric to prevent the outer fibers from pulling away from the fabric. The fabric shall be free of defects or flaws which significantly affect its physical and/or filtering properties. Sheets of fabric may be bonded together or sewn with a fungus resistant material. Do not use nylon thread for sewn seams. No deviation from any physical requirements will be permitted due to the presence of the seam.

During all periods of shipment and storage, wrap the fabric in a heavy duty protective covering to protect the fabric from direct sunlight, mud, dust, dirt, and debris. Do not expose the fabric to temperatures greater than 140°F.

When anchor pins are required, fabricate them of steel, 3/16" in diameter, at least 18" long, pointed at one end, and have a head that will retain a steel washer having an outside diameter of no less than 1.5".

When wire staples are required, provide staples that meet the requirements of Subarticle 1060-8 (D).

1056-2 ACCEPTANCE

Fabric with defects, flaws, deterioration or damage will be rejected.

Use engineering fabrics that have been evaluated by NTPEP.

Furnish a Type 1 Certified Mill Test Report, Type 2 Typical Certified Mill Test Report, or Type 4 Certified Test Report for the fabric in accordance with Article 106-3; however, the material will be subject to inspection, test, or rejection by the Engineer at any time.

1056-3 PHYSICAL PROPERTIES

See Table 1056-1.

Table 1056-1
Physical Properties of Engineering Fabrics

Physical Property	**ASTM TEST Method**	**Type 1**	**Type 2**	Type 3		**Type 4**
				Class A	**Class B**	
Typical Applications		Shoulder Drain	Under Riprap	**Temporary Silt Fence**		Soil Stabilization
Grab Tensile Strength	D4632	90 lb.	200 lb.	50 lb.	100 lb.	200 lb.
Elongation	D4632	80% Max.	15% Min.	30% Max.	25% Max.	--
Trapezoidal Tear Strength	D4533	90 lb.	90 lb.	--	--	80 lb.
Puncture Strength	D4833	45 lb.	80 lb.	30 lb.	60 lb.	80 lb.
Apparent Opening Size	D4751	#60 sieve	#60 sieve	#30 sieve		#40 sieve
Ultraviolet Exposure Strength Retention (at 500 hours)	D4355	50%	50%	70%		50%
Permeability	D4491	0.2 cm/sec	--	--		--
Permittivity	D4491	--	--	0.15 sec^{-1}		0.05 sec^{-1}

NOTES:

1. Type 1 fabric shall be non-woven needle-punched only with a minimum fabric weight of 4 oz/sy.
2. Type 3 fabric shall have 36" minimum roll width.
3. Sieve size of fabric shall be equal to or higher than value specified; opening size of fabric shall be equal or smaller than value specified.
4. All minimum strength requirements are minimum average roll values in the weakest principal direction.
5. All fabrics shall exhibit no fungal growth as tested by ASTM G21.

SECTION 1060
LANDSCAPE DEVELOPMENT MATERIALS

1060-1 GENERAL

Supply certifications for all landscape development materials as required below. If no certification is required, supply the Department with a statement certifying that all materials conform to these Specifications and those of the NC Department of Agriculture or both.

1060-2 FERTILIZER

The quality of all fertilizer and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Fertilizer Law and with the rules and regulations, adopted by the North Carolina Board of Agriculture in accordance with the requirements of said law, in effect at the time of sampling. All fertilizer will be subject to sampling and testing by the Engineer, or by an authorized representative of the North Carolina Department of Agriculture, or both.

Dry fertilizer shall be manufactured from cured stock. Care for the fertilizer during handling and storing in such a manner that it will be protected against hardening, caking, or loss of plant food values. Pulverize any hardened or caked fertilizer to its original condition before being used.

Store and care for liquid fertilizer after manufacture in a manner that will prevent loss of plant food values, and maintain or reblend a homogeneous blend of plant food elements to the original condition immediately before use.

1060-3 LIMESTONE

The quality of all limestone and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Lime Law and with the rules and regulations, adopted by the North Carolina Board of Agriculture in accordance with the requirements of said law, in effect at the time of sampling. All limestone will be subject to sampling and testing by the Engineer, or by an authorized representative of the North Carolina Department of Agriculture, or both.

Limestone shall be agricultural grade ground limestone. Either dolomitic or calcitic limestone may be used.

All limestone shall contain not less than 90 percent calcium carbonate equivalents. Dolomitic limestone shall contain not less than 10 percent of magnesium. Grade dolomitic limestone so that at least 90 percent will pass through a U.S. Standard 20 mesh screen, and at least 35 percent will pass through a U.S. Standard 100 mesh screen. Grade calcitic limestone so that at least 90 percent will pass through a U.S. Standard 20 mesh screen, and at least 25 percent will pass through a U.S. Standard 100 mesh screen. Where the current grading requirements of the North Carolina Board of Agriculture are different from the above, the requirements of the Board of Agriculture will apply.

During handling and storing, care for the limestone in such manner that it will be protected against hardening or caking. Pulverize any hardened or caked limestone to its original condition before being used.

1060-4 SEED

The quality of all seed and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Seed Law and with the rules and regulations, adopted by the North Carolina Board of Agriculture in accordance with the requirements of said law, in effect at the time of sampling, and with the quality requirements of the specifications. All seed will be subject to sampling by the Engineer, or by an authorized representative of the North Carolina Department of Agriculture, or both; and will be tested by the North Carolina Department of Agriculture. Supplementary testing for seed germination may be performed by the Engineer.

The quality of all seed will be based on the percentage of pure live seed, which will be computed by multiplying the percentage of purity by the percentage of germination and dividing the result by 100.

Seed shall have been approved by the North Carolina Department of Agriculture before being sown. No seed will be accepted with a date of test more than 8 months prior to the date of sowing, excluding the month in which the test was completed. Such testing, however, will not relieve the Contractor from responsibility for furnishing and sowing seed that meets these Specifications at the time of sowing. The Engineer may retest seed for germination after a 5 months storage period; at the beginning of each normal seeding season for the particular kind of seed involved; or at any time that the condition of the seed appears to have deteriorated.

When a low percentage of germination causes the quality of the seed to fall below the minimum pure live seed specified, the Contractor may elect, subject to the approval of the Engineer, to increase the rate of application sufficiently to obtain the minimum pure live seed content specified, provided that such an increase in the rate of application does not cause the quantity of noxious weed seed per acre or square yard, as the case may be, to exceed the quantity that would be allowable at the regular rate of application.

Furnish and deliver each of the species or varieties of seed in separate bags. If seed is to be mixed before sowing, perform such mixing in a commercial seed mixing machine or by equally thorough means after sampling and testing have been completed.

During handling and storing, care for the seed in such a manner that it will be protected from damage by heat, moisture, rodents, or other causes.

1060-5 MULCH FOR EROSION CONTROL

Mulch for erosion control shall consist of grain straw or other acceptable material, and be approved by the Engineer before being used. All mulch shall be reasonably free from mature seedbearing stalks, roots, or bulblets of Johnson Grass, Nutgrass, Sandbur, Wild Garlic, Wild Onion, , Crotalaria, and Witchweed, and free from an excessive amount of restricted noxious weeds as defined by the North Carolina Board of Agriculture at the time

of use of the mulch, and also there shall be compliance with all applicable State and Federal domestic plant quarantines. Loose and separate straw mulch that is matted or lumpy before being used.

Material for holding mulch in place shall be asphalt or other approved binding material.

1060-6 SPRIGS

Sprigs shall consist of freshly dug live stolons, or rhizomes of permanent grasses, a minimum of 2" in length, and be first class representatives of the required species or varieties specified in the specifications. The areas from which sprigs are to be obtained shall be free from Johnson Grass, Nutgrass, Sandbur, Wild Garlic, Wild Onion, Crotalaria, and Witchweed, and free from an excessive amount of restricted noxious weeds as defined by the North Carolina Board of Agriculture at the time of digging the sprigs, and also there shall be compliance with all applicable State and Federal domestic plant quarantines. The areas shall have been mowed and raked, burned off, or otherwise prepared in a manner acceptable to the engineer before digging of sprigs begins.

1060-7 SOD

Sod shall consist of a live, dense, well-rooted growth of permanent grasses, free from Johnson Grass, Nutgrass, Sandbur, Wild Garlic, Wild Onion, Crotalaria, and Witchweed, and free from an excessive amount of restricted noxious weeds as defined by the North Carolina Board of Agriculture at the time of cutting the sod, and also there shall be compliance with all applicable State and Federal domestic plant quarantines. Mow the area from which sod is to be obtained to a height of not more than 2”, and rake free of grass clippings and debris and otherwise prepared in a manner satisfactory to the Engineer before cutting of sod begins.

Cut the sod into rectangular sections of sizes convenient for handling without breaking or loss of soil. Cut it with a sod cutter or other acceptable means to a depth that will retain in the sod practically all of the dense root system of the grass.

During wet weather, allow the sod to dry sufficiently before lifting to prevent tearing during handling and placing, and during extremely dry weather water it before lifting if such watering is necessary to insure its vitality and to prevent loss of soil during handling.

1060-8 MATTING FOR EROSION CONTROL

(A) General

Matting for erosion control shall be excelsior matting or straw matting. Furnish a Type 3 Certification in accordance with Article 106-3 certifying that the matting meets the requirements of this article. Other acceptable material manufactured especially for erosion control may be used when approved by the Engineer in writing before being used. Matting for erosion control shall not be dyed, bleached, or otherwise treated in a manner that will result in toxicity to vegetation.

(B) Excelsior Matting

Excelsior matting shall consist of a machine produced mat of curled wood excelsior a minimum of 47" in width and weigh 0.975 pounds per square yard with a tolerance of plus or minus 10 percent. At least 80 percent of the individual excelsior fibers shall be 6" or more in length. Evenly distribute the excelsior fibers over the entire area of the blanket. Cover one side of the excelsior matting with an extruded plastic mesh. The mesh size for the plastic mesh shall be a maximum of 1" x 1".

(C) Straw Matting

Straw matting shall consist of a machine produced mat of 100% grain straw. The straw matting shall have a minimum width of 48" and a maximum width of 90" weighing a minimum of 0.50 pounds per square yard and a maximum of 0.75 pounds per square yard. Evenly distribute the straw over the entire area of the blanket. Cover one side of the blanket with photodegradable netting with a maximum mesh (netting) size of 0.75" by 0.75" sewn together with a degradable thread. The grain straw shall contain no weed seeds. Package each roll separately.

(D) Wire Staples

Staples shall be machine made of No. 11 gauge new steel wire formed into a "U" shape. The size when formed shall be not less than 6" in length with a throat of not less than 1" in width.

1060-9 WATER

Water used in the planting or care of vegetation shall meet the requirements of Class C fresh waters as defined in 15 NAC 2B.0200.

1060-10 PLANT MATERIALS - NURSERY GROWN

(A) General

Use all plants as called for by the contract.

Container grown plants may be used in lieu of balled and burlapped plants or bare rooted plants provided written approval for such use has been obtained from Engineer.

Grading of plants, size of root balls, and type and minimum dimensions of containers shall conform to the Specifications contained in the *American Standard for Nursery Stock*. Do not cut back plants from larger sizes to meet the sizes called for in the contract.

Botanical names referred to in the contract are taken from *Hortus Third, the Bailey Hortorium (1976 MacMillan Publishing Co., Inc.)*. All plants delivered shall be true to name. Each plant, or group of the same species, variety, and size of plant, shall be legibly tagged with the name and size of the plant.

All plants shall be first-class representatives of their species or varieties. The root system shall be vigorous and well developed. The branch systems shall be of normal

development, and free from disfiguring knots, sun scald injuries, abrasions of the bark, dead or dry wood, broken terminal growth, or other objectionable disfigurements. Trees shall have reasonably straight stems, and be well branched and symmetrical in accordance with their natural habits of growth.

All plants shall be free from plant diseases and insect pests. All shipments of plants shall comply with all nursery inspection and plant quarantine regulations of the states of origin and destination, as well as with Federal regulations governing interstate movement of nursery stock. Any nursery stock used on highway landscape projects shall be accompanied by a valid copy of a certificate of inspection, which has been granted by the North Carolina Department of Agriculture, Entomology Division. Fire Ant treatment certification, where applicable, is required.

When nursery stock from other states is used on projects in North Carolina, this stock shall be accompanied by a tag or certificate stating, in effect, that the nursery stock has been inspected and certified by an authorized official of the state of origin as apparently free from injurious plant pests.

All plant materials are subject to inspection at any time by the Engineer. Any such inspection before or during planting operations, however, will not be construed as final acceptance of the plants involved.

(B) Balled and Burlapped Plants

Dig plants, to be balled and burlapped (B&B) so as to retain a firm ball of soil and the plant's fibrous root system. The soil in the ball shall be the original and undisturbed soil in which the plant has been grown. Dig, wrap, transport, and handle the plant in such a manner that the soil in the ball will not become frozen, or loosened so as to cause stripping of the small feeding roots or movements of the soil away from contact with such roots.

(C) Container Grown Plants

Container grown plants shall be healthy, vigorous, well-rooted, and be established in the container in which they are delivered. These plants shall be in the container long enough for the fibrous roots to have developed so that the root mass will retain its shape and hold together when removed from the container. The container shall be sufficiently rigid to firmly hold the soil protecting the root mass during transporting, handling, and planting, and the soil shall not be allowed to become frozen.

(D) Bare Root Plants

Bare root plants shall have a heavy fibrous root system that has been developed by proper cultural treatment. Dig, package, transport, and handle bare root plants in a manner that will prevent injury to or drying out of the trunks, branches, or roots, or freezing of the roots. Bare root plants damaged through improper handling, damage due to freezing, drying out, etc. will result in rejection of material.

(E) Plant Substitution

No change in the Specifications (species, variety, size, caliper, furnish) will be made without written approval of the Engineer. Present all requests for substitutions in writing and include a listing of the sources that have been contacted in an attempt to secure specified plant material. Requests for substitutions shall include the botanical name, common name, cultivar, where applicable, size, caliper, and furnish description of the proposed substitute. No increase in compensation will be made to the Contractor as a result of the use of approved substitute plants. The Department reserves the right to locate specified plant material for the project when it has knowledge that specified material is available.

1060-11 MULCH FOR PLANTING

Use mulch for planting as specified in the specifications, shown on the plans, or approved by the Engineer. Mulch for planting shall not contain substances injurious to plants or which will inhibit normal development and growth of plants. Mulch for a project shall come from a single source, as approved by the Engineer, unless an additional source is submitted and approved prior to use.

1060-12 MATERIALS FOR STAKING OR GUYING

(A) Stakes

Use stakes made of cypress, cedar, oak, locust, or other acceptable wood free from defects that would impair the strength of the stake. Stakes shall be a minimum of 2" X 2" (nominal) inches square. Use stakes of the size and length as shown on the plans.

(B) Wire

Wire shall be new soft No. 14 gauge steel wire or as shown on the plans.

(C) Hose

Hose to be used with wire shall have a minimum inside diameter of 1/2". All hose shall be garden type hose composed of rubber and fabric, or as shown on the plans.

(D) Other

Other staking and guying materials may be used if a sample is submitted and approved by the Engineer prior to use.

1060-13 HERBICIDES

The herbicide to be used for a particular application shall be as specified in the specifications and/or approved by the Engineer.

Herbicides shall be properly labeled and registered with the United States Department of Agriculture and the North Carolina Department of Agriculture. A container shall contain only the herbicide that meets the analysis guaranteed on the label. Keep all herbicides in such original labeled containers until used.

Herbicide application can only be conducted by individuals who possess a pesticide license from the NC Department of Agriculture or individuals under their direction and who has read, understands, and follows the herbicide labeling before applying the product.

SECTION 1070
REINFORCING STEEL

1070-1 GENERAL

Store steel reinforcement on blocking a minimum of 12" above the ground and protect it at all times from damage; and when placing in the work make sure it is free from dirt, dust, loose mill scale, loose rust, paint, oil, or other foreign materials.

1070-2 DEFORMED STEEL BAR REINFORCEMENT FOR STRUCTURES

Supply deformed steel bar reinforcement conforming to the requirements of AASHTO M31 for Grade 60. Bend and cut during fabrication with tolerances in accordance with the *Manual of Standard Practice* published by the Concrete Reinforcing Steel Institute. Bend the bars cold to the details shown on the plans.

1070-3 COLD DRAWN STEEL WIRE AND WIRE FABRIC

Provide cold drawn steel wire for use as spirals or in fabricated form for the reinforcement of concrete meeting the requirements of AASHTO M32. Epoxy coat all spacers on spirals when the spirals are epoxy coated.

Use welded wire fabric conforming to AASHTO M55.

1070-4 REINFORCING STEEL BAR SUPPORTS

Make all wire bar supports of smooth cold drawn industrial quality basic wire having a minimum tensile strength of 65,000. When the legs of the bar supports are in contact with the forms, ensure that the entire leg of the bar support is stainless steel wire or a minimum thickness of 1/4" stainless steel at points of contact with the forms. Use stainless steel wire meeting the requirements of ASTM A493 except having a minimum chromium content of 16 percent and a minimum tensile strength of 95,000 psi. Ensure that wire sizes, height tolerance, and leg spacing for wire bar supports are in accordance with the requirements listed in the current *Manual of Standard Practice* published by the Concrete Reinforcing Steel Institute.

As an option to the stainless steel wire for the legs of bar supports at points of contact with the forms, provide legs of cold drawn steel wire plastic protected in accordance with the current *Manual of Standard Practice* published by the Concrete Reinforcing Steel Institute, except provide plastic protection by dipping or by premolded plastic tips. Do not use plastic legs molded to the top wire.

1070-5 PRESTRESSING STRAND

Use prestressing strands for use in prestressed concrete consisting of 7-wire strands, stress relieved after manufacture to remove internal stresses. Use the size and the grade of the strand as shown on the plans. Use strands conforming to the requirements of

AASHTO M203 except provide a specimen for test purposes, if required, from each reel of cable instead of each 20 ton production lot.

For precast prestressed deck panels, use 3/8” round seven-wire stress-relieved Grade 250 or 270 prestressing strands meeting the requirements of AASHTO M203.

Mark the outer layer of each reel pack of strand with a wide color band as follows: white for Grade 270 stress relieved strand, green for low relaxation strand, and a double marking of green and red for special low relaxation strand. In addition, attach a metal tag to each reel pack labeled in accordance with AASHTO M203.

1070-6 DOWELS AND TIE BARS FOR PORTLAND CEMENT CONCRETE PAVEMENT

Use smooth plain round steel dowel bars conforming to the requirements of AASHTO M31 Grade 60. Do not use dowel bars with burred ends. A tolerance of ±1/4" is permitted from the dowel length required by the plans. A straightness tolerance of 0.075" from a straight line is permitted.

Epoxy coat all dowel bars in accordance with AASHTO M284 and these provisions, with a coating thickness of 7 to 13 mils after curing. Coated bars will be taken by the Engineer from the production run on a random basis at the point of coating application for testing and evaluation. The Engineer determines the sampling and testing schedule for the number and frequency of tests for thickness of coating, adhesion of coating, and holidays. A minimum of one bar for each 20 coated is tested for holidays and coating thickness. Perform a minimum of 2 bend tests for each 8 hours of production coating or any fraction thereof for determining that adhesion and flexibility of the coating meets specification requirements. Payment is not made by the Department for coated bars selected for testing and evaluation purposes at the point of coating application. All coated bars are inspected at both the coating and fabrication shops. Furnish a Type 1 Certified Mill Test Report and attach it to a completed Department of Transportation reinforcing steel certification Form Number 913 for all coated reinforcing bars before cleaning and coating operations, of the time and location where the work is performed.

Use dowel assemblies for supporting dowel bars of rigid construction capable of holding the dowel bars in proper position during placing of concrete, and of such design to permit unrestricted movement of the pavement slab. Use wire for dowel assemblies meeting the requirements of AASHTO M32. Use a dowel assembly that holds the dowels in the required position within a tolerance of 1/4" in vertical and horizontal planes. Obtain written approval for the dowel assembly prior to use.

Coat dowel bars and the entire dowel assembly with an approved wax base coating. Apply the coating by dipping or spraying such that the wax coating on the dowel bars is of uniform thickness sufficient to allow pulling of the dowel from the concrete as provided in AASHTO T253 and M254. Furnish to the Department for testing 1 dowel basket assembly for each 200 assemblies incorporated into the project.

Use deformed tie bars conforming to the requirements of AASHTO M31 for Grade 40 or Grade 60.

1070-7 BLANK

1070-8 EPOXY COATED REINFORCING STEEL

(A) General

Coaters of epoxy coated reinforcing steel shall establish proof of their competency and responsibility in accordance with the Concrete Reinforcing Steel Institute's Fusion Bonded Epoxy Coating Applicator Plant Certification Program. Registration and certification of the plant or shop under the CRSI Program and submission of the valid annual certificate to the State Materials Engineer is required prior to beginning any coating. The same requirement applies to coaters subcontracting work from the coater directly employed by the contractor.

Obtain approval of each coater and/or fabricator of epoxy coated reinforcing steel prior to coating or fabricating bars. Approval is based upon: (a) the coating applicator and/or fabricator establishing and maintaining an effective quality control program and (b) the coating applicator having equipment for cleaning, coating, and/or fabricating that produces coated material conforming to these Specifications. Include in requests for approval a well defined quality control program and direct the requests to the State Materials Engineer. Before Department approval is issued, the condition of equipment for blast cleaning, coating and/or fabricating material is evaluated by the Engineer for determining the equipment capability of producing a coated product conforming to the Specifications. A list of Department approved epoxy coating and/or fabricating companies is available from the State Materials Engineer.

(B) Coating Materials

Obtain approval for the epoxy resin powder prior to use. A list of prequalified powder sources is available from the State Materials Engineer.

Submit prequalified products other than those now approved for use to the State Materials Engineer for approval. Requalify each product every 5 years and any time a change is made in the manufacturing process or chemical composition of the epoxy resin.

Use powdered resin of any color that provides contrast to the corroded or uncorroded surface of the steel. Provide material of the same quality as that used for prequalification tests and as represented by test reports forwarded to the State Materials Engineer.

Have the manufacturer of the epoxy resin supply to the coating applier information on the resin that is considered essential to the proper use and performance of the resin as a coating. Have the manufacturer of the resin furnish the coating applier a written certification signed by a responsible officer of the company that the material furnished for coating the reinforced steel is the same formulation as that for which test reports were previously submitted to the State Materials Engineer.

With each batch of coating material, furnish a written certification by the coating applier to the Engineer which properly identifies the batch number, material, quantity

represented, date of manufacture, name and address of manufacturer, and includes a statement that the supplied coating material is the same composition as that prequalified.

(C) Patching Material

Have the epoxy resin manufacturer supply a prequalified and approved patching or repair material that is compatible with the coating and inert in concrete. Ensure that the material is suitable for making repairs with a minimum dry film thickness of 6 mils from two coats on damaged areas of the coating. Ensure that each coater, fabricator, and contractor has a copy of the manufacturer's written instructions for application of the patching material and the instructions are closely followed during coating damage repairs.

Apply two coats of patch material where needed with the second coat applied only after the first coat dries to the touch. Do not apply any patch material when the surface temperature of the steel or the air temperature is below 40°F. Do not ship or place steel until the patch material is dry to the touch.

(D) Reinforcing Steel

Use coated steel reinforcing bars meeting the requirements of AASHTO M31, Grade 60 and free of contaminants such as oil, grease, and paint. Use bars free of surface irregularities that produce holidays in the coating. Have the coater visually inspect the bars to avoid coating bars containing such surface irregularities. If the coater fails to detect surface irregularities that produce holidays in the coating, patch the holidays with 6 mils of patching material as specified in Subarticle 1070-8(C) to avoid rejection of the bars.

(E) Surface Preparation of Bars

Subject coated reinforcing steel surfaces to a very thorough blast (near white) cleaning, prior to coating. Ensure that the appearance of the surface after cleaning corresponds to ASTM D2200 and the pictorial standards of SSPC Specifications VIS 1, degree of cleaning SSPC-SP10. Produce a suitable anchor pattern profile by the cleaning media. A target profile depth of approximately one third the coating thickness is considered a suitable anchor pattern.

Apply the coating to the cleaned surface as soon as possible after cleaning. Remove any formation of rust blooms on the cleaned bars by blast cleaning before application of the coating. However, never delay the coating more than 8 hours after cleaning unless otherwise permitted. Provide surface characteristics of the steel as described above at the time of coating.

After blast cleaning, and before application of the coating, remove all visible traces of grit and dust from the bars.

(F) Application of Coating

Apply the coating as an electrostatically charged dry powder sprayed into the grounded steel bar using an electrostatic spray gun. Apply the powder to either a hot or cold bar. Give the coated bar a thermal treatment as specified by the manufacturer

of the epoxy resin that provides a fully cured and bonded finish coating. Control temperature as recommended by the manufacturer of the coating material to ensure a workmanlike finish without blistering or other defects. Completely coat all bars, including bar ends, with epoxy resin powder to the minimum thickness specified in Subarticle 1070-8(G).

Run the production line at such a speed as to provide proper cure time prior to quench by air or water.

(G) Quality Control Requirements

For acceptance purposes, ensure that each recorded film thickness measurement is in the range of 7 to 12 mils after cure, with the entire area of a bar having a minimum coating thickness of 7 mils.

A single recorded coated reinforcing bar thickness measurement is the average of three individual readings obtained from three adjacent areas on the body of the bar (three adjacent areas between deformations). Obtain a minimum of five recorded measurements approximately evenly spaced along each side of the test bar (a minimum of ten recorded measurements per bar).

Have the coating applier visually inspect each coated bar after cure for continuity of coating and to ensure that the coating is free of holes, voids, contamination, cracks, and damaged areas discernible to the unaided eye. In addition, no more than an average of two holidays per linear foot of bar are permitted providing the total quantity of holidays does not exceed five in any linear foot. Bars that contain no more than five holidays in any linear foot of bar are acceptable provided any holidays in excess of two per linear foot are coated with 6 mils of patching material specified in Subarticle 1070-8(C). Retest the bars after patching to confirm that no more than 2 holidays exist in any linear foot of bar.

Have the coating applier evaluate the adhesion of the coating on a representative number of bars selected by the Engineer from each proposed shipment as specified in Subarticle 1070-8(L). No visible cracks or disbonding of the coating are allowed when tested in accordance with Subarticle 1070-8(H).

(H) Test Methods Required of the Coater

The thickness of the coating is measured on the body of the bar between the deformations or ribs. Conduct non-destructive coating thickness measurements using magnetic gages in accordance with ASTM G12, with the following additions applicable to commercially available pull-off gages, and to fixed probe gages with a magnetic field of vision not exceeding 0.015" of steel depth [0.015" is the minimum thickness of smooth steel to which adding more material does not change the zero reading].

Perform gage calibration with shims on a smooth, clean low-carbon steel plate (with minimum dimensions of 3" by 3 1/2", rather than on a cleaned reinforcing bar.

Determine a correction factor defining the effect of the bar preparation process as the difference between (a) the average of ten gage readings on a cleaned, but uncoated reinforcing bar of the size and lot coated, and (b) the average of five gage readings on

a smooth mild steel plate. This correction factor is then subtracted from all subsequent gage readings on coated bars.

Fixed probe gages are checked to ensure that the force generated by the springloaded probe housing is sufficient to ensure intimate contact between the probe tip and the coatings of the curved bar surface. If intimate contact does not result, remove the probe housing and utilize hand pressure to obtain valid indicated thickness readings.

As an option, use thumbwheel pulloff gages to provide valid thickness measurements on coated reinforcing bars with a deformation spacing which is less than the maximum outer dimensions of the probe housing. Position the base of the probe housing against the top of two adjacent deformations and extend the probe through the air gap to the body of the bar. Hold the gage very steady and apply continuous light downward pressure to the housing during the measurement.

Use a 67.5V holiday detector equipped with a holiday marker in accordance with the detector manufacturer's instructions. Maintain the detector in perfect working condition at all times during the bar coating process. Immediately after coating, route each bar through the detector for holiday detection. Bars containing more than five holidays in a linear foot of bar or averaging more than two holidays per foot of bar are either rejected or cleaned, recoated, and retested for holidays. A coating holiday for the purpose of this specification is defined as a discontinuity in the applied coating that occurs during the coating process that is detected either visually or electromechanically.

The adhesion of the coating is evaluated by bending production coated bars 120 degrees (after rebound) around a mandrel of specified size as prescribed in Table 1070-8(1). Conduct the bend test at a uniform rate and take up to 90 seconds to complete. Place the two longitudinal deformations in a plane perpendicular to the mandrel radius, and maintain the test specimen at thermal equilibrium between 68°F and 85°F. If the specimen for the adhesion of coating shows evidence of cracking or debonding of the coating, conduct two retests on random samples. If the results of both retests meet the specified requirements, the coated bars represented by the samples are acceptable.

TABLE 1070-8(1)
Bend Test Requirements

Bar No.	Mandrel Diameter, In.
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
14	17
18	23

The fracture or partial failure of the steel-reinforcing bar in the bend test for adhesion of coating is not considered as an adhesion failure of the coating. If failure of the bar occurs, test two check samples without bar failure.

Condition test bars at a temperature range of 68°F to 85°F. In cases of dispute, conduct tests at 73°F and 50% relative humidity in accordance with Recommended Practices ASTM D-3451.

(I) Handling and Identification

Provide padded contact areas for all systems for handling coated bars at the coating plant, fabricator, and project. Pad or suitably band all bundling bands to prevent damage to the coating. Lift all bundles of coated bars with a strong back, spreader bar, multiple supports or a platform bridge to prevent bar-to-bar abrasion from sag in the bundles of coated bars.

(J) Fabrication of Steel-Reinforcing Bars After Coating

Protect drive rolls and automatic kick-off levers on shear beds, and drive pins, center pins, and back-up barrels on benders with a suitable covering to minimize damage during the fabrication process. Note that these Specifications permit a maximum of 5 percent of the surface area of a bar to contain patching material. This includes patching due to damage to the coating by the coater, fabricator, transporter, and contractor.

Store coated bars as required by Subarticle 1070-8(M).

Have the fabricator maintain the identification of the coated bars, and assure that the coated, fabricated bars are identified with proper tags for final shipment to the job site.

Perform coating repairs as described in Subarticle 1070-8(K) with material specified in Subarticle 1070-8(C).

Flame cutting of coated bars to the required dimensions is not permitted. Maintain any mechanical device used for cutting the coated bars to required length in good working order to minimize damaging the coating in the vicinity of the cut ends. Repair coating damage in these areas as described in Subarticle 1070-8(K) with material specified in Subarticle 1070-8(C).

(K) Procedures for Repair of Coating

Repair all coating damage of the reinforcing bars with material described in Subarticle 1070-8(C) when coating bond loss and damage exist, including crushed coating and hairline cracking if bare metal is evident. When repair is required, clean and repair all damage. Remove crushed coating and loose or deleterious material. In areas where rust is present, remove it by wire brushing with a power tool to the surface finish specified in Subarticle 1070-8(E) prior to repair.

(L) Inspection by the Department:

Coated bars are inspected at both the coating and fabrication shops unless otherwise approved. The coater and/or fabricator is required to furnish mill test reports attached to a completed Department of Transportation Reinforcing Steel Certification Report (Form 913) for all coated reinforcing bars. Also include a completed Epoxy Coated Reinforcing Bar Inspection Report (Form 310) with each shipment. These certification forms are available from the State Materials Engineer. Do not epoxy coat, fabricate, or ship reinforcing steel to the project site without the approval of the Engineer.

Provide free entry to the plant and facilities of the coater and/or fabricator for the inspection of all manufacturing processes including but not limited to the cleaning, coating and fabrication of the ordered bars.

On a random basis, lengths of coated bars or fabricated bars are taken from the production run at the point of coating application for testing and evaluation.

All bar tests are made at the coating applicator and/or fabricator's plant, prior to shipment, unless otherwise approved. Have the coating applier and/or fabricator notify the State Materials Engineer five working days prior to the time the material is coated or fabricated. Do not ship bars until they are inspected and tagged by the Department.

The Engineer randomly selects three coated bars of each size from each proposed shipment to test for holidays, damage and coating thickness. If any bar fails to conform to these Specification requirements, six (6) samples are selected and tested. If these tests reveal that the coating conforms to Specification requirements the shipment is acceptable. If any of the second set of samples fail to conform to these Specifications the coater is required to test all bars of that size that are included in the shipment and re-submit the shipment to the Department for inspection. The Engineer selects from each proposed shipment 2 samples of each size bar for bend tests by the coater for determining that the adhesion and flexibility of the coating conforms to Subarticle 1070-8(H).

(M) Repairs to Coating Due to Loading, Transporting, and Handling

Transport the bundled bars from the coater or fabricator to the project site with padding, such as carpet padding or used carpet, placed over each bundle of steel upon which another bundle of steel is placed unless wooden spacers are placed between each bundle to prevent contact.

Load all bundles of bars horizontally for transporting. Transport the bars on a flatbed trailer. Do not allow the length of bars extending beyond the trailer bed to exceed 8 feet.

Repair coating damage due to handling and transporting or other causes with material specified in Subarticle 1070-8(C) and in accordance with Subarticle 1070-8(K).

(N) Rejection

Coated bars that do not meet the requirements of this Specification are rejected. At the Contractor's option, replace coated bars containing defects beyond the limits of these Specifications. Alternatively, strip the bars of coating, reclean, and recoat in accordance with the requirements of this Specification.

1070-9 SPIRAL COLUMN REINFORCING STEEL

Furnish spiral column reinforcing steel with the following areas and weights as required by the plans:

	Size	Area, in^2	Weight, lbs./ft
Plain Cold Drawn Wire	W 20	0.20	0.668
	W31	0.31	1.043
Deformed Cold Drawn Wire	D-20	0.20	0.680
	D-31	0.31	1.054
Plain or Deformed Bar	#4	0.20	0.668
	#5	0.31	1.043

Use cold drawn wire conforming to the requirements of AASHTO M32. Use plain or deformed bars conforming to the requirements of AASHTO M31 for Grade 60. Use deformed cold drawn wire conforming to the requirements of AASHTO M225.

The diameter of the spiral reinforcing steel is the outside to outside measurement of the bars or wire, with an allowance of 1/2" more or 1/2" less than the specified diameter as shown on the plans.

Furnish spirals with 11/2 extra turns at top and at bottom of the completed spiral cage. Where splicing of the spirals is necessary other than those shown on the plans, provide a minimum lap splice of 3 feet.

Do not weld on the spiral reinforcing.

When required by the plans, use epoxy coated spiral column reinforcing steel including spacers in accordance with Article 1070-8.

Use the minimum number of spiral spacers as shown on the plans. Ensure a minimum section modulus per spiral spacer of 0.030 in^3.

1070-10 MECHANICAL BUTT SPLICES

When called for by the contract or when directed by the Engineer, use a mechanical butt reinforcing steel splice from an approved source. Use a standard metal filled sleeve, cement mortar filled sleeve, threaded steel couplings, forged steel sleeve, cold-forged sleeve. An exothermic process whereby molten filler metal, contained by a high strength steel sleeve of larger inside diameter than the bars, is introduced into the annular space between the bars and the sleeve and also between the ends of the bars may also be used. Provide a splice that is capable of transferring at least 125% of the yield strength of the bars from one bar to the other by the mechanical strength of the splice components.

For splices not on the approved list, prior to use and as a condition of approval, assemble three test splices in the presence of the Engineer for each size of bar which is proposed for use on the project. Forward the test splices to the North Carolina Department of Transportation's Materials and Tests Unit in Raleigh, N.C. for testing and approval.

SECTION 1072
STRUCTURAL STEEL

1072-1 GENERAL

Furnish and fabricate all structural steel and related incidental materials including sign supports and high mount lighting standards and use materials in accordance with this section.

(A) Fabricator Qualification

Steel fabricators are required to establish proof of their competency and responsibility in accordance with the American Institute of Steel Construction's (AISC) Quality Certification Program in order to perform work for the project. Registration and certification of the plant or shop under the AISC program and submission of a valid certificate to the State Materials Engineer is required prior to beginning fabrication. Submit annually an endorsed copy to the State Materials Engineer for continued qualification. The same requirements apply to fabricators subcontracting work from the fabricator directly employed by the Contractor.

Employ fabricators of high mount lighting standards in excess of 80 feet in length, structural steel components of fender systems, retaining walls and noise walls, sign supports, sign structures, pot and expansion bearings, simple span rolled beams, including those requiring cover plates, solar array platforms and modular expansion joints that are AISC certified in Simple Steel Bridges. Employ fabricators of heat curved rolled beams, rolled beams for continuous spans, and plate girders that are AISC certified in Major Steel Bridges. Employ fabricators of fracture critical bridge beams and girders that also have a Fracture Critical Members Endorsement from AISC. Ensure that fabricators applying over 1500 square feet of coating have

a Sophisticated Paint System Endorsement from AISC or a Quality Procedure Three Certification from the Society of Protective Coatings.

(B) Office

Ensure that fabricators of main structural steel components of bridges provide an office area with an approximate floor space of 100 square feet, a desk or drafting table, 2 chairs, telephone, facilities for proper heating and cooling, telephone, separate dial-up or faster internet access and adequate lighting and located at the plant site for the exclusive use of the Engineer. Have fabricators of other structural steel items furnish reasonable work areas for the Engineer.

1072-2 STRUCTURAL STEEL OF FOREIGN ORIGIN

When electing to utilize major elements of structural steel that are manufactured outside the United States, furnish such materials only from those foreign manufacturers who establish, to the satisfaction of the Engineer, the adequacy of their in-plant quality control to give satisfactory assurance of their ability to furnish material uniformly and consistently in conformance with the Specifications. Major elements of structural steel are considered to be rolled shapes, plates for girder flange and web components or beam cover plates, and any other structural steel element not listed elsewhere as a minor element that is considered by the Engineer of sufficient importance to be included in this category.

Provide proof of adequacy and obtain approval before incorporating foreign manufactured major structural steel elements into the work. Establish proof by either (1) providing the Engineer with a detailed written certification by an established and approved Independent Testing and Inspection Laboratory or Agency showing evidence that the foreign manufacturer previously established in-plant quality control to give assurance of their ability to furnish material uniformly and consistently in conformance with the Specifications, or (2) a thorough in-plant inspection of the foreign manufacturer's facilities by the Engineer or his appointed representative.

Cover the cost of determining such adequacy, established either by detailed written evidence or a thorough in-plant inspection by the Engineer or his appointed representative. Make payment of all expenses incurred by the Engineer or his appointed representative in making such in-plant inspection to the N. C. Department of Transportation upon receipt of detailed billing prepared by the N. C. Department of Transportation.

Prior to fabrication of major elements of foreign produced structural steel, obtain all applicable certified mill test reports clearly identifiable to the lot of material by heat numbers and color coding and submit these reports for review, analysis, and acceptance.

The above requirements for submission and approval of certified mill test reports also apply to minor elements of foreign produced steel, except that a supplier's certification as to grade of steel is acceptable for steel which is difficult to identify on any mill test report. Ensure that the supplier's certification lists the elements covered by the certification and the pounds of steel required for each element. Minor elements are considered to be anchor bolts, pipe sleeves, masonry plates, sole plates, diaphragm tees, connector plates, web stiffener plates, and any other element not classified as a major element.

Deliver structural steel materials to the fabrication site and store a sufficient period of time to permit inspection, sampling, and testing as deemed necessary by the Engineer prior to fabrication. Make all pieces of all materials available for inspection, sampling, and testing.

1072-3 FABRICATION OF STRUCTURAL STEEL OUTSIDE CONTINENTAL LIMITS OF UNITED STATES

Notify the Engineer at the earliest possible date after award of the contract as to the proposed site of structural steel fabrication to allow the Engineer to make all necessary arrangements for structural steel fabrication inspection. When electing to have items of structural steel fabricated outside the continental limits of the United States, reimburse the Department for all costs connected with inspection of such fabrication, including necessary expenses for the Engineer or his representative to make an in-plant inspection of the fabrication facilities and to arrange for an inspection agency to perform the shop inspection of fabrication.

Fabrication inspection includes the determination before fabrication that the material furnished is tested and approved for the project, and checks of material sizes, fabrication details, welds, welding procedures, welders, girder fit-ups, all cleaning and painting of members, and paints to ascertain that requirements of the contract are met. A detailed description of all duties of a shop inspector is available upon request from the Materials and Tests Unit.

All correspondence, telephone conversation, and other communication from the Department, other than from the in-plant inspection representative, shall be with the Contractor and not with the foreign fabricator.

1072-4 SHAPES, PLATES, BARS, AND SHEETS

Use shapes, plates, bars, and sheets meeting the requirements of AASHTO M270 Grade 36 unless otherwise required by the contract. For painted beams or girders, use sheet material of 1/32" in thickness meeting the requirements of ASTM A366 or ASTM A569, and sheet material of 1/16" through 5/32" thickness meeting the requirements of ASTM A570 for Grades 36, 40, or 45. For unpainted beams or girders, use sheet material less than 3/16" thickness meeting the requirements of ASTM A606 for Type 4.

1072-5 BEARING PLATE ASSEMBLIES

Unless otherwise shown on the plans, galvanize steel bearing assemblies for both structural steel beams and girders and prestressed concrete girders. Galvanize anchor bolts, nuts, and washers in accordance with AASHTO M232. Cut pipe sleeves and collars from Schedule 40 PVC plastic pipe meeting the requirements of ASTM D1785.

Except for attachments of bearing plates to beams, fabricate and weld bearing plate assemblies before galvanizing the steel. Seal all joints of welded parts with weld material. After the fabrication of the bearing plate assembly is complete, galvanize the assembly in accordance with AASHTO M111. For prestressed concrete girders, clean welds made for attaching bearing plates to beams or girders and give them 2 coats of organic zinc repair paint having a minimum total coating thickness of 3 dry mils. For steel beams and girders, clean and paint in accordance with Article 442-10.

Repair galvanized surfaces that are abraded or damaged at any time after the application of the zinc coating by thoroughly wire brushing the damaged areas and removing all loose and cracked coating, after which give the cleaned area 2 coats of organic zinc repair paint having a minimum total coating thickness of 3 dry mils.

Use zinc rich paint meeting the requirements of Article 1080-9.

1072-6 ANCHOR BOLTS

Unless otherwise stated herein, use anchor bolts meeting the requirements of AASHTO M183 or ASTM A307 for Grade A.

Provide anchor bolts for bearing plate assemblies meeting the requirements of ASTM A449.

Swedge anchor bolts for a distance equal to the embedment length minus 3" measured from the embedded end.

Hot-dip galvanize anchor bolts, nuts and washers in accordance with AASHTO M232.

1072-7 HIGH STRENGTH BOLTS, NUTS, AND WASHERS

(A) General

Furnish all AASHTO M164 high-strength bolts, nuts and washers, including direct tension indicators, in accordance with the appropriate AASHTO or ASTM Materials Specifications as amended and revised herein.

Furnish the Engineer a copy of the manufacturer's test report for each component. Have the report indicate the testing date, the city and state where the components were manufactured, the lot number of the material represented, the rotational capacity tests lot number and the source identification marking used by the manufacturer of each component. On test reports for direct tension indicators, also include the tension load at which indicators are tested, gap clearance, nominal size and coating thickness.

Produce each permanent fastener component installed in a structure from domestically processed material containing the grade identification markings required by the applicable reference specification and the manufacturer's source identification marking. A copy of the source identification marking used by each manufacturer is on file with the Department's Materials and Tests Unit.

Obtaining permanent bolts, nuts, and washers in any one structure from different manufacturers is allowed provided:

(1) All bolts are produced by only one manufacturer.

(2) All nuts are produced by only one manufacturer.

(3) All washers are produced by only one manufacturer.

Have all fasteners used in a structure furnished by the fabricator of the steel. Require the fabricator to submit the fasteners for sampling and testing a minimum of 5 weeks before delivery to the project site. Sample and test each diameter and length of bolt, nut, and washer assembly as follows:

Lot Quantity	Number of Samples
0-800	3 Assemblies
801-8000	6 Assemblies
> 8000	9 Assemblies

Ship only those fasteners to the project that are sampled, tested, and approved. Protect the material from moisture during storage such that it does not contain any indication of rust at the time of installation. Ensure that each component contains a thin coat of lubricant at the time of installation.

When galvanized high strength bolts are required, use bolts, nuts, and washers meeting the requirements of Subarticle 1072-7(F).

When corrosion resistant structural steel is required by the plans, provide fasteners with atmospheric corrosion resistance and weathering characteristics comparable to that of the structural steel.

(B) Specifications

(1) Ensure that all bolts meet the requirements of AASHTO M164 and these Specifications.

(2) Ensure that all nuts meet the requirements of AASHTO M292 as applicable or AASHTO M291 and these Specifications. Completely coat each nut with a wax lubricant.

(3) Ensure that all washers meet the requirements of AASHTO and these Specifications.

(4) Ensure that all direct tension indicators meet the requirements of ASTM F959 and these Specifications.

(C) Manufacturing

(1) Bolts

(a) Hardness for bolt diameters 1/2" to 1" inclusive are noted below:

Bolt Size, In.	Hardness Number			
	Brinell		Rockwell C	
	Min.	Max.	Min.	Max.
1/2" to 1"	248	311	24	33

(2) Nuts

(a) Heat treat galvanized nuts to Grade 2H, DH, or DH3.

(b) Use plain (ungalvanized) nuts of Grades 2, C, D, or C3 with a minimum Rockwell hardness of 89 HRB (or Brinell hardness 180 HB), or heat treat to Grades 2H, DH, or DH3. (The hardness

requirements for Grades 2, C, D, and C3 exceed the current AASHTO/ASTM requirements).

(c) Tap oversize galvanized nuts the minimum amount required by AASHTO M291. Overtap the nut such that the nut assembles freely on the bolt in the coated condition and meets mechanical requirements of AASHTO M291 and the rotational-capacity test herein.

(3) Marking Mark all bolts, nuts and washers in accordance with the appropriate AASHTO/ASTM Specifications.

(4) Direct Tension Indicators

(a) For Type 3 high strength bolts, mechanically galvanize direct tension indicators to AASHTO M298 Class 50, and then apply baked epoxy to a thickness of 1 mil minimum. Direct tension indicators need not be mechanically galvanized or epoxy coated if they are made from material conforming to the requirements applicable to AASHTO M164, Type 3 bolts.

(b) For plain Type 1 high strength bolts, provide direct tension indicators that are plain or mechanically galvanized to AASHTO M298 Class 50.

(c) For galvanized Type 1 high strength bolts, mechanically galvanize direct tension indicators to AASHTO M298 Class 50.

(D) Testing

(1) Bolts

(a) Proof load tests (ASTM F606 Method 1) are required at the minimum frequency as specified in AASHTO M164 Paragraph 9.2.4.

(b) Wedge tests on full size bolts (ASTM F606 Paragraph 3.5) are required. If bolts are galvanized, perform the tests after galvanizing. Test at a minimum frequency as specified in AASHTO M164 Paragraph 9.2.4.

(c) If galvanized bolts are supplied, measure the thickness of the zinc coating. Take measurements on the wrench flats or top of bolt head.

(2) Nuts

(a) Proof load tests (ASTM F606 Paragraph 4.2) are required at the minimum frequency of as specified in AASHTO M291 Paragraph 9.3 or AASHTO M292 Paragraph 7.1.2.1. If nuts are galvanized, perform the tests after galvanizing, overtapping and lubricating.

(b) If galvanized nuts are supplied, measure the thickness of the zinc coating. Take measurements on the wrench flats.

(3) Washers

(a) If galvanized washers are supplied, perform hardness testing after galvanizing.

(b) Remove the coating prior to taking hardness measurements.

(c) If galvanized washers are supplied, measure the thickness of the zinc coating.

(d) Test direct tension indicators in accordance with ASTM F959.

(4) Assemblies

Rotational-capacity tests are required. Have the manufacturer or distributor perform such tests on all black or galvanized (after galvanizing) bolt, nut and washer assemblies prior to shipping. Washers are required as part of the test.

The following applies:

(a) Except as modified herein, perform the rotational-capacity test in accordance with the requirements of AASHTO M164.

(b) Test each combination of bolt production lot, nut lot and washer lot as an assembly. Where washers are not required by the installation procedures, do not include in the lot identification.

(c) Assign a rotational-capacity lot number to each combination of lots tested.

(d) The minimum frequency of testing is two assemblies per rotational-capacity lot.

(e) Assemble the bolt, nut and washer assembly in a Skidmore-Wilhelm Calibrator or an acceptable equivalent device (This requirement supersedes the current AASHTO M164 requirement to perform the test in a steel joint). For short bolts that are too short for assembly in the Skidmore-Wilhelm Calibrator, see Subarticle 1072-7(D)(4)(i).

(f) The minimum rotation, from a snug tight condition (10% of the specified proof load), is: 240 degrees (2/3 turn) for bolt lengths less than 4 diameters; 360 degrees (1 turn) for bolt lengths greater than 4 diameters and less than 8 diameters; 480 degrees (1 1/3 turn) for bolt lengths greater than 8 diameters.

(g) These values differ from the AASHTO M164 Table 8 Specifications.

Achieve tension at the above rotation equal to or greater than 1.15 times the required installation tension. The installation tension and the tension for the turn test are shown below.

Diameter, In.	**1/2**	**5/8**	**3/4**	**7/8**	**1**	**1 1/8**	**1 1/4**	**1 3/8**	**1 1/2**
Req. Installation									
Tension, kips	12	19	18	39	51	56	71	85	103
Turn Test									
Tension, kips	14	22	32	45	59	64	82	98	118

(i) After the required installation tension listed above is exceeded, one reading of tension and torque is taken and recorded. The torque value shall conform to the following:

Torque - less than or equal to 0.25 PD

Where

Torque = measured torque in foot-pounds

P = measured bolt tension in pounds

D = bolt diameter in feet

For bolts that are too short to test in a Skidmore-Wilhelm Calibrator, test in a steel joint. The tension requirement of Section (D)(4)(h) is computed using a value of P equal to the turn test tension shown in the Table in Section (D)(4)(h).

(5) Reporting

(a) Record the results of all tests (including zinc coating thickness) required herein and in the appropriate AASHTO specifications on the appropriate document.

(b) Report the location where tests are performed and date of tests on the appropriate document.

(6) Witnessing

Witness of the test by an inspection agency is not required; however, have the manufacturer or distributor performing the tests certify that the recorded results are accurate.

(7) Documentation

(a) Mill Test Report(s) (MTR)

(i) Furnish MTR for all mill steel used in the manufacture of the bolts, nuts, or washers.

(ii) Indicate in the MTR the place where the material was melted and manufactured, the lot number of the material represented and the source identification used by the manufacturer.

(b) Manufacturer Certified Test Report(s) (MCTR)

(i) Have the manufacturer of the bolts, nuts and washers furnish test reports (MCTR) for the item furnished.

(ii) Include in each MCTR the relevant information required in accordance with Section (D)(5).

(iii) Have the manufacturer performing the rotational-capacity test include on the MCTR:

a. The lot number of each of the items tested.
b. The rotational-capacity lot number as required in Subarticle 1072-7(D)(4)(c).
c. The results of the tests required in Subarticle 1072-7(D)(4).

d. The pertinent information required in Subarticle 1072-7(D)(5)(b).

e. A statement that the MCTR for the items are in conformance to this Specification and the appropriate AASHTO specifications.

f. The location where the bolt assembly components were manufactured.

(c) Distributor Certified Test Report(s) (DCTR)

(i) Ensure that the DCTR includes MCTR above for the various bolt assembly components.

(ii) Have the rotational-capacity test performed by a distributor or a manufacturer and reported on the DCTR.

(iii) Include in the DCTR the results of the tests required in Subarticle 1072-7(D)(4).

(iv) Include in the DCTR the pertinent information required in Subarticle 1072-7(D)(5)

(v) Include in the DCTR the rotational-capacity lot number as required in Subarticle 1072-7(D)(4)(c).

(vi) Ensure that the DCTR certifies that the MCTR are in conformance to this Specification and the appropriate AASHTO specifications.

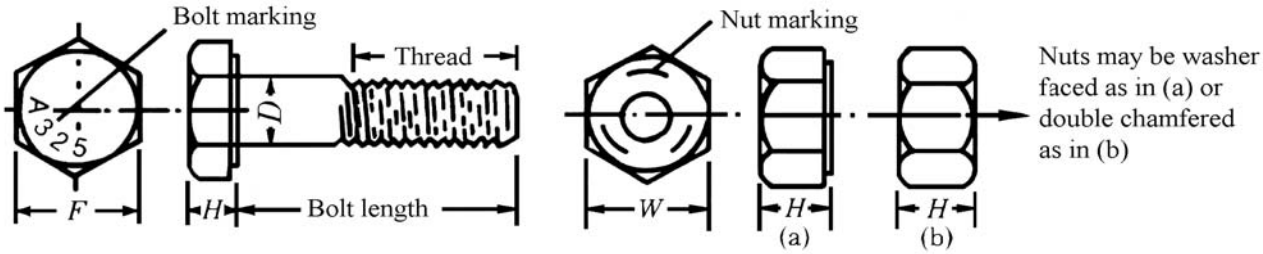
(E) Shipping

(1) Ship bolts, nuts and washers (where required) from each rotational - capacity lot in the same container. If there is only one production lot number for each size of nut and washer, shipping of the nuts and washers in separate containers is allowed. Permanently mark each container on the side with the rotational-capacity lot number such that identification is possible at any stage prior to installation.

(2) Provide the appropriate MTR and MCTR or DCTR to the contractor or owner as required by the contract.

TABLE 1072-1
HIGH STRENGTH BOLTS BOLT AND NUT DIMENSIONS

Nominal Bolt Size (D)	Bolt Dimensions, In Inches Heavy Hexagon Structural Bolts			Nut Dimensions, In Inches Semi-Finished Heavy Hexagon Nuts	
	Width Across Flats (F)	Height (H)	Thread Length (T)	Width Across Flats (W)	Height (H)
1/2	7/8	5/16	1	7/8	31/64
5/8	1 1/16	25/64	1 1/4	1 1/16	39/64
3/4	1 1/4	15/32	1 3/8	1 1/4	47/64
7/8	1 7/16	35/64	1 1/2	1 7/16	55/64
1	1 5/8	39/64	1 3/4	1 5/8	63/64
1 1/8	1 13/16	11/16	2	1 13/16	1 7/64
1 1/4	2	25/32	2	2	1 7/32
1 3/8	2 3/16	27/32	2 1/4	2 3/16	1 11/32
1 1/2	2 3/8	15/16	2 1/4	2 3/8	1 15/32



NOTE: Bolt and nut marking varies. See Subarticle 1072-7(B).

TABLE 1072-2
HIGH STRENGTH BOLTS
WASHER DIMENSIONS[a]

	Circular Washers				Square or Rectangular Beveled Washers for American Standard Beams and Channels		
Bolt Size	Nominal Outside	Nominal Diameter	Thickness		Minimum Side	Mean	Slope of Taper In
D	Diameter	of Hole	Min.	Max.	Dimension	Thickness	Thickness
1/2	1 1/16	17/32	.097	.177	1 3/4	5/16	1:6
5/8	1 5/16	11/16	.122	.177	1 3/4	5/16	1:6
3/4	1 15/32	13/16	.122	.177	1 3/4	5/16	1:6
7/8	1 3/4	15/16	.136	.177	1 3/4	5/16	1:6
1	2	1 1/8	.136	.177	1 3/4	5/16	1:6
1 1/8	2 1/4	1 1/4	.136	.177	2 1/4	5/16	1:6
1 1/4	2 1/2	1 3/8	.136	.177	2 1/4	5/16	1:6
1 3/8	2 3/4	1 1/2	.136	.177	2 1/4	5/16	1:6
1 1/2	3	1 5/8	.136	.177	2 1/4	5/16	1:6
1 3/4	3 3/8	1 7/8	.178[b]	.28[b]	--	--	--
2	3-3/4	2-1/8	.178[b]	.28[b]	--	--	--
Over 2 to 4 Incl.	2D-1/2	D+1/8	.24[c]	.34[c]	--	--	--

[a] Dimensions in inches

[b] 3/16 in. nominal

[c] 1/4 in. nominal

(F) Galvanized High Strength Bolts, Nuts, and Washers

Use galvanized high strength bolts, nuts, and washers meeting all other requirements of this subarticle except as follows:

(1) Use Type 1 bolts.

(2) Quench and temper washers.

(3) Mechanically galvanize in accordance with the requirements of AASHTO M232 Class C.

(4) Ship galvanized bolts and nuts in the same container.

(5) Use organic zinc repair paint for touch-up of galvanized surfaces meeting the requirements of Article 1080-9.

(6) Include in manufacturer's test reports results of the zinc coating thickness measurements.

(7) Have each galvanized nut coated with a wax lubricant with a color contrast to that of the zinc coating.

1072-8 WELDED STUD SHEAR CONNECTORS

Use Type B shear studs as defined by the current edition of the ANSI/AWS/AASHTO Bridge Welding Code D1.5.

Use and install welded stud shear connectors meeting the requirements of Article 1072-20. Ensure that shear studs and the areas of beams, girders or other structural steel to which the studs are welded are free of rust, rust pits, oil, grease, moisture, paint, galvanizing, loose mill scale or other deleterious matter which adversely affects the welding operation. Apply shear studs on steel with tightly adhering mill scale as determined by the Engineer provided acceptable results are achieved and the installed studs meet the testing requirements of the Bridge Welding Code.

1072-9 INSPECTION

(A) General

Give the Materials and Tests Unit 72 hours notice for in-state producers and 192 hours notice for producers out-of-state prior to beginning work in the shop. Do not manufacture or fabricate any material, other than stock items, before the Materials and Tests Unit is notified and the final shop drawings are reviewed, accepted and returned to the fabricator.

The contractor/fabricator shall be responsible for and shall be required to perform all quality control procedures and nondestructive testing in accordance with the Bridge Welding Code and as required by the Contract documents. Perform all quality control procedures and nondestructive testing in the presence of the Department's inspector unless otherwise approved by the Department's inspector. Obtain approval for all quality control inspectors from the Department's inspector and ensure their qualification in accordance with the Bridge Welding Code. Maintain all Quality Control Reports as required by the Bridge Welding Code, including but not limited to visual and nondestructive testing reports and all phases of coating application inspection. Provide copies of all Quality Control Reports, including all radiographic films, to the Department inspector upon request. These copies become the property of the Department. No separate payment is made for this inspection and testing. The entire cost of this work is included in the unit contract price for the structural steel item(s) involved.

Furnish facilities for the inspection of material and work in the mill and shop, and allow the inspectors free access to the necessary parts of the mill or shop. Do not ship any member or component of the structural steel from the shop to the job site prior to approval by the Department's inspector. Such approval is stamped on the member or appropriate container by the Department's inspector.

Furnish the Engineer with as many copies of mill orders and shipping statements as directed. The acceptance of any material or finished member by the Department's inspector is not a bar to their subsequent rejection, if found defective. Replace rejected material and correct rejected work promptly and satisfactorily.

(B) Shop and Mill Inspection

Shop inspection is performed on all structural steel used on any project. Mill inspection of structural steel is performed when so noted on the plans or in the Specifications. Furnish complete certified mill test reports for all structural steel used except that a Type 6 supplier's certification as to grade of steel used is acceptable for small amounts of structural steel items which are furnished from the supplier's stock and which are difficult to identify on any mill test report.

Show in the supplier's certification the items fabricated from stock material and the pounds of steel required for each item. A supplier's certification represents only anchor bolts, pipe sleeves, masonry plates, sole plates, diaphragm tees, connector plates, and web stiffener plates. Represent all other items required for a structure by certified mill test reports as specified above.

Indicate in the complete certified mill test reports the pounds of steel and the item or items they represent and show heat number of steel, mechanical tests, chemical analyses, Department's project number, station number, the ASTM or AASHTO specification to which the material conforms, and a signed statement certifying where the steel was melted and manufactured.

Forward to the Materials and Tests Unit a letter which states by station the items and pounds of steel that are represented by a supplier's certification and those represented by certified mill test reports identifying the beam and/or plate material for each main member.

The Department reserves the right to select any item for test. Bear any expense of obtaining the sample. The tests are performed at the Department's expense.

(C) Sampling Structural Steel

Furnish samples of structural steel at the beginning of fabrication when random sampling is required.

Furnish one sample 2 1/2" x 24" for each grade of steel used on a project. If more than 10 heat numbers are involved in any grade of steel, 2 samples of that grade are required.

Take all samples at the location and in the manner directed by an authorized representative of the Engineer. Furnish the necessary personnel and equipment for obtaining samples and be responsible for providing a smooth finish to the areas from which the samples are taken.

(D) Charpy V-Notch Tests

Furnish all structural steel for main beam and girder members (for girder members see plans) and for diaphragms and crossframes connecting horizontally curved members meeting the longitudinal Charpy V-Notch Tests specified in the supplementary requirements in AASHTO M270 for zone 1. Unless otherwise noted on the plans, mark and test the materials as non-fracture critical. Sample and test in accordance with AASHTO T243 and use the (H) frequency of heat testing. Use the grade or grades of structural steel required in the plans. Obtain and submit certified

mill test reports to the Materials and Tests Unit to show the results of each test required by this Specification.

Material failing to meet the qualification requirements outlined above is unacceptable for use on the project.

1072-10 WORKING DRAWINGS

Submit prints of checked structural steel shop drawings and changes thereto, including shipping diagrams, for review, comments, acceptance and distribution as follows:

(A) Submit 2 sets for review, comments, and acceptance on all steel structures. After review, comments, and acceptance, submit 7 sets for distribution.

(B) Submit 5 sets for review, comments, and acceptance for all bridges carrying railroad traffic, and after acceptance submit 9 sets for distribution.

(C) Furnish any additional sets requested by the Engineer or for his use, review, comments, acceptance and/or distribution.

Shop drawings are not checked by the Engineer except to ascertain general compliance with the design and the Specifications. Thoroughly check all shop drawings in all respects. Review, comments, and acceptance of shop drawings by the Engineer is not considered as relieving the Contractor of his responsibility for the accuracy of his drawings, or for the fit of all shop and field connections and anchors.

The maximum size of prints for shop drawings is 22" x 36", including borders which are at least 1" at the left edge of the sheet. Provide shop drawings on any medium provided they are legible and are reproducible. Upon completion of the project, furnish to the Engineer one complete set of reproducible shop drawings that represent the as built condition of the structural steel including all approved changes if any. Supply drawings that are 22" x 36". These drawings will become the property of the Department.

Changes on shop drawings after acceptance and/or distribution are subject to the approval of the Engineer. Furnish a record of such changes.

Make substitution of sections different from those on the structure plans only when approved in writing.

1072-11 HANDLING AND STORING MATERIALS

Load, transport, unload and store structural material so that the metal is kept clean and free from damage. Repair any coating damage. Do not use chains, cables, or hooks that damage or scar the material. Repair all materials which are scarred or damaged and inspect at the fabricators expense as deemed necessary by the Engineer.

Use lifting equipment and rigging equipment with adequate capacity to handle the material at all times. Do not bend, twist, damage, or excessively stress any materials. Operate and maintain all lifting equipment in a safe manner and in accordance with the manufacturer's directions.

When lifting main structural steel members, the use of spreader bars is preferred. Avoid one-point pick-ups if possible. Do not use one point pick-ups on members over 50 feet in

length. Use two point pick-ups so that the amount of overhang and the distance between hooks does not exceed the distances as noted in the following table:

	BEAM SIZE			
	30" or Less	33" WF	36" WF	Plate Girders
Distance Between Hooks (LF) Max	74'	80'	85'	100'
Overhang (LF) Max	25'	28'	30'	35'

Store structural material, either plain or fabricated, above the ground upon platforms, skids, or other supports, keep free from dirt, grease, vegetation, and other foreign matter, and protect as far as practicable from corrosion.

Keep material clean and properly drained. Transport and store girders and beams with the web in the vertical plane and the top flange up. Request permission in writing and await approval to invert haunched girders and beams for transport for safety reasons. Use extreme care in turn-over operations to prevent excessive bending stresses in the edge of flanges. Support long members on blocking placed near enough together to prevent damage from deflection.

Do not use any beam, girder, diaphragm, cross frame or other material, in any stage of fabrication that will be permanently incorporated into the finished structure as a workbench, lifting device, dunnage or for any purpose for which it was not specifically intended.

1072-12 STRAIGHTNESS, CAMBER, AND DIMENSIONAL TOLERANCES

(A) General

Ensure that rolled material, before being laid out or fabricated, is straight. If straightening is necessary, use methods that do not damage the metal. Kinks or sharp bends are cause for rejection of the material.

Ensure that heat straightened or heat cambered parts are substantially free from external forces, except those resulting from mechanical means used in conjunction with the application of heat.

After heating, allow the metal to cool without artificial cooling down to 600°F. Below 600°F, only dry compressed air is permitted to artificially cool steels having minimum yield strength greater than 36,000 psi as indicated by a mill test report.

(B) Straightening

Straighten distorted members and bent material by mechanical means or, if approved, by the carefully planned and supervised application of a limited amount of localized heat. Do not allow the temperature of the heated area to exceed 1200°F as controlled by temperature indicating crayons or other approved methods.

Following the straightening of a bend or buckle, free the surface of the metal from evidence of fracture as indicated by visual inspection or, if directed, by appropriate nondestructive testing.

Shop straighten the bottom flanges of steel beams or girders at bearings as necessary to provide uniform contact between the flanges and the bearings.

(C) Camber

Show the required camber on the drawings.

Make adequate provision in the fabrication of structural members to compensate for change of camber due to welding of the shear connectors and other fabrication work.

Fabricate camber into the members on built-up plate girders and trusses. Where camber is required on rolled sections, induce it by heat cambering, except that for rolled sections within the depth, length, and camber ordinate range shown in Table 1072-3, induce camber by cold cambering or "gagging" at the mill or in the shop provided approval procedures for cold cambering are employed.

Attach cover plates on rolled sections after cambering.

Where reverse curvature is required in a single rolled shape, induce it by heat cambering.

Show camber diagrams showing the required offset at each tenth point of the span and at any web splice or field splice location and blocking diagrams on the shop drawings. Show additional points if desired by the fabricator. Ensure that the beams, girders, or other members with field splices meet all of the blocking ordinates without inducing stress into the members.

Following cambering or camber correction, correct evidence of fracture indicated by visual inspection or, if directed, by appropriate nondestructive testing.

Show camber and blocking diagrams on the shop drawings. Shop assemble continuous beams meeting all the blocking ordinates without inducing stress into the members.

TABLE 1072-3
ACCEPTABLE COLD CAMBER FOR ROLLED SECTIONS

	Section Designation and Nominal Depth	
Beam Length, Feet	W Shapes 14" to 21" Inclusive S Shapes 12" and Over	W Shapes 24" and Over
Over 30 through 42	3/4" to 2 1/2" inclusive	1" to 2" inclusive
Over 42 through 52	1" to 3" inclusive	1" to 3" inclusive
Over 52 through 65	2" to 4" inclusive	2" to 4" inclusive
Over 65 through 85	2 1/2" to 5" inclusive	3" to 5" inclusive
Over 85 through 100	As directed by the Engineer	3" to 6" inclusive

(D) Heat Cambering of Rolled Beams and Welded Plate Girders

(1) General

Where heat cambering is used, only Deep-Vee heating is permitted. Perform Deep-Vee heating by the carefully planned and supervised application of a limited amount of localized heat.

When minor corrections in camber are required, use small localized heats limited to the flange material. Perform major corrections in camber by Deep-Vee heating to prevent web distortion.

Begin heating at the apex of the heating pattern and progress slowly towards the base of the pattern as each area is brought up to temperature as stated in Subarticle 1072-12(D)(5). Do not return the heating torch toward the apex of the heating triangle after heating has progressed towards the base.

Do not progress the heating torches toward the base of the heating pattern until the apex of the pattern is brought up to the specified temperature. Continue heating to successive areas until the base of the triangular heating pattern is brought up to the required temperature across the full width of the flange.

(2) Heat Cambering of Rolled Beams

Heat cambering of rolled beams is allowed to provide the required vertical curvature. Space triangular heating patterns throughout the length of the member to provide the required curvature. Locate the apex of the heating triangle at a point not less than 75 percent of the depth of the member measured from the flange that is concave after cambering. Limit the total included angle of the heating pattern to 20 degrees.

Weld all detail material such as connection plates, bearing stiffeners, and gusset plates attached to the member to the rolled beam after the beam is cambered as required.

(3) Heat Cambering of Welded Plate Girders

Heat cambering of welded plate girders is only permitted when approved in writing as a necessary repair procedure for plate girders rejected for camber deviation.

When it is necessary to correct camber deviation in welded plate girders, heating is permitted in Deep-Vee heating patterns centered on intermediate stiffeners and connection plates. Where necessary, add stiffeners for this purpose if approved. Locate the apex of the heating pattern not less than 3/4 of the depth of the member from the flange that is shortened after cooling. The maximum included angle of the heating pattern is 10 degrees. The maximum width of the base of the heating pattern is 10". Where shallow members or thin webs prescribe heating patterns with a width substantially less than 10" at the junction of the web to flange, extend the heating pattern in the flange at that location beyond the limits of the heating pattern in the web

by a maximum of 1" provided the total width of pattern in the flange does not exceed the 10" limit stated above.

(4) Support of Members for Heat Cambering

Heat camber members with the web vertical and supports spaced to take the maximum advantage of dead load in the member before applying heat. Have all supports approved by the Inspector before beginning work.

Do not place any combination of support system or external load on the member that causes a compressive stress in the flange to exceed 20,000 psi before heating for AASHTO M270 Grade 36, Grade 50 and Grade 50W steels.

(5) Heating Process and Equipment

Heat using large, approximately 1" diameter, multi-orifice (rosebud) heating torches operating on approximately 25 psi thermal gas and 125 psi oxygen.

The torches and tips used are subject to approval. Choose torches and tips that promote heating efficiency and prevent unnecessary distortion.

Confine heating to the patterns described herein and conduct so as to bring the steel within the planned pattern to a temperature between 1100 and 1200° F as rapidly as possible without overheating the steel.

Any heating procedure which causes a portion of the steel to exceed a temperature greater than 1,200 °F is considered destructive heating and is automatically cause for rejection of the steel. Steel rejected for destructive heating is investigated for re-acceptance, repair, or replacement if allowed by the Engineer. Bear the cost of such tests and any necessary repair or replacement.

(6) Heat Measurement

Specified temperatures are checked using portable digital pyrometers.

(E) Heat Curving Girders

(1) Type of Heating

With approval, use continuous or V-type heating methods to curve girders. For the continuous method, simultaneously heat a strip along the edge of the top and bottom flanges that is of sufficient width and temperature to obtain the required curvature. For V-type heating, heat the top and bottom flanges simultaneously in truncated triangular or wedge-shaped areas. Position the areas with their base along the flange edge and spaced at regular intervals along each flange. Set the spacing and temperatures to approximate the required curvature by a series of short chords. Heat along the top and bottom flanges at approximately the same rate.

For V-type heating, terminate the apex of the truncated triangular area applied to the inside flange surface just before the juncture of the web and flange. To avoid web distortion, make certain that heat is not applied directly to the web when heating the inside flange surfaces (the surfaces that intersect the web).

Extend the apex of the truncated triangular heating pattern applied to the outside flange surface to the juncture of the flange and web. Use an included angle of approximately 15 to 30 degrees in the truncated triangular pattern, but do not allow the base of the triangle to exceed 10 ". Vary the patterns prescribed above only with the Engineer's approval.

For both types of heating, heat the flange edges that will be on the inside of the horizontal curve after cooling. Concurrently heat both inside and outside flange surfaces for flange thickness 1¼ inches and greater. Adhere to the temperature requirements presented below.

(2) Temperature

Conduct the heat-curving operation so that the temperature of the steel never exceeds 1150°F as measured by temperature indicating crayons or other suitable means. Do not artificially cool the girder until it naturally cools to 600°F; Use dry compressed air to artificially cool the girder.

(3) Position for Heating

Heat-curving the girder with the web in either a vertical or horizontal position is permitted. When curved in the vertical position, brace or support the girder so that the tendency of the girder to deflect laterally during the heat-curving process does not cause the girder to overturn.

When curved in the horizontal position, support the girder near its ends and at intermediate points, if required, to obtain a uniform curvature. Do not allow the bending stress in the flanges to exceed 27,000 psi. To prevent a sudden sag due to plastic flange buckling when the girder is positioned horizontally for heating, place intermediate safety catch blocks at the midlength of the girder within 2 inches of the flanges at all times during the heating process.

(4) Sequence of Operations

Conduct the heat-curving operation either before or after completing all the required welding of transverse intermediate stiffeners to the web. However, unless provisions are made for shrinkage, position and attach connection plates and bearing stiffeners after heat-curving. In any event, weld the stiffeners, connection plates, and bearing stiffeners to the girder flanges after the member is curved. If longitudinal stiffeners are required, heat-curve or oxygen-cut these stiffeners separately prior to welding to the curved girder.

(5) Camber

Camber the girders before heat-curving. Cut the web to the prescribed camber allowing for shrinkage due to cutting welding, and heat-curving. If approved, a carefully supervised application of heat is permitted to correct moderate deviations from the specified camber.

(6) Measurement of Curvature and Camber

Horizontal curvature and vertical camber is measured for final acceptance after all welding and heating operations are complete and the flanges have cooled to a uniform temperature. Horizontal curvature is checked with the web in the vertical position by measuring offsets from a string line or wire attached to both flanges or by using other suitable means. Camber is checked with the web in the horizontal position. Camber the girder so that it meets the horizontal and vertical curvature ordinates without inducing stress into the girders by mechanical force.

Compensate for loss of camber in the heat-curved girders as residual stresses dissipate during service life of the structure. This anticipated loss of camber is computed in accordance with the *AASHTO Standard Specifications for Highway Bridges* as shown on the plans.

Clearly define the deviation in accordance with Subarticle 1072-12(D) from curvature that should be reasonably close to what AWS allows which is 1/8" per 10 foot length.

(7) Procedure Specification and Shop Drawings

Submit structural steel shop drawings, including a detailed written procedure specification for heat curving the girders, supplemented by calculations and sketches, for review, comments and acceptance. On the shop drawings, indicate the type, location, and spacing of heat sectors, if used, supports, and catch blocking for each field section of girders. Also, include suitable blocking diagrams for measuring horizontal curvature similar to those usually prepared for camber and vertical curvature.

(F) Camber Measurement

At the time of acceptance at the shop and after erection, ensure that all stringers and girders for bridges meet the required camber values within the tolerances specified in Subarticle 1072-12(F). Follow the procedure for measuring camber as outlined below:

(1) Assemble the member at the shop as specified in Article 1072-21 and measure with the member lying on its side.

(2) Camber repairs are only allowed when approved by the Engineer. Camber deviation is judged irreparable if corrective measures in the shop produce web buckling in excess of the specified tolerance, in which case the member is rejected.

(3) The final camber measurement is made by the Engineer in the field after erection. At the time of this measurement, ensure that the members have all of the specified camber less the dead load deflection of the steel as specified in Subarticle 1072-12(F).

(G) Dimensional Tolerances

Ensure that dimensions of all material covered by Section 1072 conform to ASTM A6 when received at the fabrication shop. Fabricate member dimensions conforming to this subarticle whether designated to be straight, cambered, or curved and regardless of whether curvature is heat-induced (when so permitted). Dimensional tolerances not listed in this subarticle shall be as specified by the Bridge Welding Code as defined in Article 1072-20 and apply to rolled shapes where applicable as well as to welded members.

Place welded butt joints no further than 1/2" from the point detailed. Intermediate stiffeners varying ±1/2" maximum from the point detailed are allowed. Connector plates for field connections varying ±1/8" from the point detailed are allowed. Ensure that the actual centerline of bearing lies within the thickness of the bearing stiffener.

Members with end milled for bearing and members with faced end connection angles deviating from the detailed length by -0, +1/32" maximums are acceptable. All other members varying from detailed length by ±1/8" maximum are acceptable.

Align to within ±1/8" from the location shown on the approved shop drawings all steel requiring shop assembly for reaming, drilling from the solid or weld joint preparation.

Deviation from specified camber of fabricated members prior to shipment from the fabrication shop is limited to:

-0;
$+\frac{3/32\text{" x No. of ft. from nearest bearing}}{10}$ up to 3/4" maximum

Deviation from specified camber of erected steel bridge superstructures measured when the steel work is complete and the superstructure is subject to steel dead load stresses only is limited to:

-0;
$\frac{+1/8\text{" X No. of ft from nearest bearing}}{10}$ up to 1" maximum

If the plans do not require shop induced camber, provide an actual member that is straight or one of the following:

(1) If natural camber "turned up" is required, the maximum plus camber is the algebraic sum of the allowable deviation, dead load deflection, vertical curve ordinate, and superelevation ordinate;

(2) If natural camber 'turned down" is required, the maximum negative camber is equal to the algebraic sum of the dead load deflection, vertical curve ordinate, and superelevation ordinate.

1072-13 OXYGEN CUTTING

Oxygen cutting of structural steel is allowed, provided a smooth surface free from cracks and notches is secured and an accurate profile is secured by the use of a mechanical guide. Hand cut only where approved and grind smooth leaving no burnt edges.

In all oxygen cutting, adjust and manipulate the cutting agent to avoid cutting beyond (inside) the prescribed lines. Provide oxygen cut surfaces meeting the ANSI surface roughness rating value of 1,000 except ensure that oxygen cut surfaces of members not subject to calculated stress meet the surface roughness value of 2,000. Round corners of oxygen cut surfaces of members carrying calculated stress to a 1/16" radius, or an equivalent flat surface at a suitable angle, by grinding after oxygen cutting.

Fillet re-entrant cuts to a radius of not less than 1".

Remove surface roughness exceeding the above values and occasional notches, gouges, and cracks not more than 1/16" deep on otherwise satisfactory oxygen cut surfaces by chipping or grinding. Flair corrections of the defects with the surface of the cut on a bevel of 1 to 6 or flatter.

Repair occasional gouges of oxygen cut edges more than 3/16" deep but not more than 7/16" deep by welding with low hydrogen electrodes not exceeding 5/32" in diameter and with a minimum preheat of 250°F. Grind the completed weld smooth and flush with the adjacent surface. Radiographically test any gouge over 1/8" deep after the repair.

1072-14 EDGE PLANING

Plane sheared edges of plates more than 5/8" in thickness that carry calculated stress to a depth of 1/4". Fillet re-entrant cuts before cutting. Round all edges of plates and shapes parallel to calculated stress and all free edges of plates and shapes intended for coating or galvanizing to 1/16" radius or provide an equivalent flat surface at a suitable angle. Grind edges of all other plates and shapes to remove burrs, slag, or shear lip. The ends of all steel piles, intended for coating or galvanizing, are not required to be radiused, but remove all burrs, slag, and shear lip.

1072-15 FACING OR BEARING SURFACES

Provide a surface finish of bearing and base plates and other bearing surfaces that come in contact with each other or with concrete that meet the following ANSI surface roughness requirements as defined in ANSI B46.1, Surface Roughness, Waviness, and Lay, Part I:

Steel slabs .....ANSI 2,000
Heavy plates in contact in shoes to be welded .....ANSI 1,000
Milled ends of compression members, milled or
ground ends of stiffeners and fillers .....ANSI 500
Bridge rollers and rockers .....ANSI 250
Pins and pin holes .....ANSI 125
Sliding bearings .....ANSI 125

1072-16 ABUTTING JOINTS

Face and bring to an even bearing abutting joints in compression members and girder flanges, and in tension members where so indicated on the drawings. Where joints are not faced, do not exceed an opening of 1/4".

1072-17 BENT PLATES

Provide cold-bent, load carrying rolled-steel plates conforming to the following:

(A) Take from the stock plates so that the bendline is at right angles to the direction of rolling.

(B) Use a radius of bends such that no cracking of the plate occurs. Use minimum bend radii, measured to the concave face of the metal, as shown in Table 1072-4.

If a shorter radius is essential, bend the plates hot at a temperature not greater than 1200°F and air cool slowly down to a temperature of 600°F. Below 600°F only dry compressed air is permitted to artificially cool steels having a minimum yield strength greater than 36,000 psi. Use hot bent plates conforming to requirement 1 above.

(C) Before bending, round the corners of the plates to a radius of 1/16" throughout the portion of the plate at which bending occurs.

TABLE 1072-4
MINIMUM BEND RADII

Plate Thickness (t), Inches	Minimum Bend Radii, Ratio of Thickness
Up to 1/2	2t
Over 1/2 to 1	2 1/2t
Over 1 to 1 1/2	3t
Over 1 1/2 to 2 1/2	3 1/2t
Over 2 1/2 to 4	4t

NOTE: Hot bend low alloy steel in thicknesses over 1/2" for small radii, if required.

1072-18 HOLES FOR BOLTS AND OTHER FASTENERS

(A) General

Punch or drill all holes and remove any burrs. Punching material forming parts of a member composed of not more than 5 thickness of metal 1/16" larger than the nominal diameter of the fastener is allowed whenever the thickness of the material is not greater than 3/4" for structural steel, 5/8" for high-strength steel, or 1/2" for quenched and tempered alloy steel, unless subpunching and reaming is required by Subarticle 1072-18(D).

When there are more than 5 thicknesses or when any of the main material is thicker than 3/4" for structural steel, 5/8" for high-strength steel, or 1/2" for quenched and tempered alloy steel, either subdrill and ream or drill all holes full size.

When required by Subarticle 1072-18(D), subpunch or subdrill all holes (subdrill if thickness limitation governs) 1/4" smaller and, after assembling, ream 1/16" larger or drill full size to 1/16" larger than the nominal diameter of the fastener.

(B) Punched Holes

Do not use a diameter of the die exceeding the diameter of the punch by more than 1/16". If any holes require enlargement to admit the fasteners, ream such holes. Clean cut holes without torn or ragged edges. Poor matching of holes is cause for rejection. Grind all burrs smooth.

(C) Reamed or Drilled Holes

Make reamed or drilled holes cylindrical, perpendicular to the member, and complying with the size requirements of Subarticle 1072-18(A). Where practicable, direct reamers by mechanical means. Grind all burrs smooth. Poor matching of holes is cause for rejection. Ream and drill with twist drills. If required, take assembled parts apart for removal of burrs caused by drilling. Assemble connecting parts requiring reamed or drilled holes, securely hold while reaming or drilling and match mark before disassembling.

(D) Subpunching and Reaming of Field Connections

Subpunch or subdrill, if required according to Subarticle 1072-18(A), holes in all field connections and field splices of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders, and rigid frames. Subsequently ream while assembled as required by Article 1072-21. Subpunch and ream to a steel template or ream while assembled all holes for floor beam and stringer field end connections. Ream or drill full size field connection holes through a steel template after the template is located with utmost care as to position and angle and firmly bolted in place. Use templates for reaming matching members, or the opposite faces of a single member that are exact duplicates. Accurately locate templates used for connections on like parts of members such that the parts or members are duplicates and require no match-marking.

(E) Accuracy of Punched and Subdrilled Holes

Accurately punch or subdrill all holes punched full size, subpunched, or subdrilled such that after assembling (before any reaming is done) a cylindrical pin 1/8" smaller in diameter than the nominal size of the hole enters perpendicular to the face of the member, without drifting, in at least 75 percent of the contiguous holes in the same plane. If the requirement is not fulfilled, the badly punched pieces are rejected. If any hole does not pass a pin 3/16" smaller in diameter than the nominal size of the hole, this is cause for rejection.

(F) Accuracy of Reamed and Drilled Holes

When holes are reamed or drilled, ensure that 85 percent of the holes in any contiguous group, after reaming or drilling, show no offset greater than 1/32" between adjacent thicknesses of metal.

Use all steel templates with hardened steel bushings in holes accurately dimensioned from the centerlines of the connection as inscribed on the template. Use the centerlines in locating accurately by the template from the milled or scribed ends of the members.

(G) Alternate Methods

As an option, make the fastener holes by procedures other than those described in Subarticles 1072-18(A) through 1072-18(F) provided that the requirements for quality and for dimensional accuracy are met. Wherever an alternate method is employed, demonstrate the ability of each alternate method to produce holes and connections consistently meeting all requirements for quality and dimensional accuracy for the type of joint fabricated. When such ability of an alternate method is previously demonstrated on similar work for the Department, continue its use by certifying, on each subsequent project, that the procedure and equipment are the same as the method previously qualified, and that the equipment involved is in good repair and adjustment. Failure of joints to meet the quality and accuracy requirements is cause for rejection. In the case of repeated failures revise and/or requalify the method or discontinue its use.

At the time of qualification of an alternate method, submit for approval a written procedure specification describing the procedures and equipment and giving upper and lower value limits and tolerances for all pertinent variables. Accurately reflect the actual procedures, equipment, and values used in the qualification tests. In addition to the certification on each subsequent project, the Engineer occasionally requests copies of the approved procedure specification.

(H) Oversize, Short-Slotted, and Long-Slotted Holes

Where shown on the plans or permitted in writing, use oversize, short-slotted, and long-slotted holes with high strength bolts 5/8" and larger in diameter. Do not allow the distance between edges of adjacent holes or edges of holes and edges of members to be less than permitted under the AASHTO specification. Oversize, short-slotted, and long-slotted holes are defined as follows:

(1) Oversize holes are 3/16" larger than bolts 7/8" and less in diameter, 1/4" larger than bolts 1" in diameter, and 5/16" larger than bolts 1 1/8" and greater in diameter. When oversized holes are permitted, they are allowed in any or all plies of friction type connections. Install hardened washers over exposed oversize holes.

(2) Short-slotted holes are 1/16" wider than the bolt diameter and have a length that does not exceed the oversize diameter requirements of Sub-paragraph 1 by more than 1/16". When short-slotted holes are permitted, they are allowed in any or all plies of friction-type or bearing-type connection. Locate holes without regard to direction of loading in friction-type connections, but orient normal to the direction of the load in bearing-type connections. Install hardened washers over exposed short-slotted holes.

(3) Long-slotted holes are 1/16" wider than the bolt diameter and have a length more than allowed in Sub-paragraph 2 but not more than 2 1/2 times the bolt diameter. Structural plate washers or a continuous bar not less than 5/16" in thickness are required to cover long slots that are the outer plies of joints. Ensure that these washers have a size sufficient to completely cover the slot after installation. When long-slotted holes are permitted, they are allowed in only one of the connected parts of either a friction-type or bearing-type connection at an individual faying surface.

When used in friction-type connections, locate holes without regard to direction of loading if one-third more bolts are provided than needed to satisfy the allowable unit stresses except as herein restricted.

When used in bearing-type connections, orient the long diameter of the slot normal to the direction of loading. No increase in the number of bolts over those necessary for the allowable unit stress is required.

(I) Misfits

When misfits occur for any reason, enlargement of the holes by reaming is limited to 1/16" over the nominal size hole called for unless otherwise permitted in writing.

(J) Erection Bolt Holes

At field welded connections where erection bolts are used, provide holes 3/16" larger than the nominal erection bolt diameter.

1072-19 INSTALLING BOLTS

Install high strength bolts in accordance with the requirements of Article 440-10.

1072-20 WELDING

(A) Definition

The Bridge Welding Code referred to herein is the edition of the ANSI/AWS/AASHTO Bridge Welding Code D-1.5 and any applicable interim that is current on the date of advertisement for the project, and as modified by the specifications.

(B) General

Weld all structural steel in the shop or in the field for bridges, whether permanent or temporary, and perform all other work related to structural welding including, but not limited to, testing and inspection of welds, preparation of material, oxygen cutting, electrodes, shielding, and shear studs, meeting the requirements of the Bridge Welding Code. Weld other steel items in accordance with the requirements of the applicable AWS Welding Code.

Weld only where shown on the plans or where called for in the Specifications unless requesting and receiving written approval for additional welding.

Show all permanent and all temporary welds on the shop drawings. For groove welds, indicate on the shop drawings the particular detail and process to be employed

in production of the work. For prequalified joints, use of the Bridge Welding Code letter classification designation of the joint (B-L2b-S etc.) along with the appropriate symbol satisfies this requirement. Tack welds that become part of a permanent weld are not required on the shop drawings.

Provide fillet welds, including seal welds, at least the minimum size allowed by the Bridge Welding Code for the thickness of material welded or the size called for on the plans, whichever is larger. For exposed, bare, unpainted applications of steel, the basic requirements for weld filler metal with atmospheric corrosion resistance and coloring characteristics similar to that of the base metal are mandatory. The variations from these basic requirements listed in the Bridge Welding Code for single pass welds are not permitted.

Use only Department approved electrodes for welding. The Department maintains a list of approved brands of electrodes for which satisfactory reports of tests made within one year are previously submitted. This list is available from the State Materials Engineer. Designate an appropriate storage area for all welding consumables that meets all requirements of the Bridge Welding Code.

(C) Qualification of Personnel

Ensure that each welder, welding operator and tacker is qualified in accordance with the Bridge Welding Code or other applicable AWS Welding Code as determined by the Engineer. Employ welders that are qualified by the Department. Welders shall be requalified by the Department every five years. Contact the Materials and Tests Unit to schedule qualification tests. Permanent in-shop welders employed by a fabricator who passed the appropriate welding tests and whose weldments are radiographically tested with acceptable results on a regular basis are exempt from additional testing when approved by the Engineer. Have a representative of the testing agency witness all phases of the qualification tests including preparation of the test plates and placing of welds. As evidence of such qualification, furnish a satisfactory certificate, or a copy thereof, issued by a testing agency which is approved by the Engineer, for each welder, welder operator, and tacker employed on the work. Submit certification for each welder, welding operator, or tacker, and for each project, stating the name and Social Security number of the welder, welding operator, or tacker; the name and title of the person who conducted the examination; the kind of specimens; the position of welds; the American Welding Society electrode classification used; the results of the tests; and the date of the examination. Such certifications are required for all persons performing shop or field welds of any kind on the work, whether permanent or temporary. Have each welder provide a picture ID upon request or other form of positive identification as required by the Engineer.

(D) Qualification of Welds and Procedures

Use welds, except as otherwise provided below, that are prequalified in accordance with the details, limitations, and procedures prescribed by the Bridge Welding Code or other AWS Welding Code as determined by the Engineer. Substitute other such prequalified welds for those shown on the plans, subject to the approval of the

Engineer. Use welds departing from those prequalified only if submitting to the Engineer details of the proposed joints and joint welding procedure Specification for approval, and at no cost to the Department demonstrate their adequacy in accordance with the requirements of the Bridge Welding Code.

Include in procedure specifications, upper and lower value limits of all variables listed for procedure qualification in the Bridge Welding Code for the process or processes used. Written welding procedure specifications are required for prequalified welds also.

On all welding, include in the welding procedure continuous visual inspection by welders, welding operator, tackers, welding supervisors, and all personnel involved in preparation of the material for welding.

Approval by the Engineer of the procedure specifications does not relieve the Contractor of his responsibility to develop a welding procedure that produces weldments meeting the required quality and dimensions.

If non-prequalified joints procedures are previously found acceptable to the Engineer on another project, furnish the inspector with a copy of the joint details and procedure specification approved at the time of qualification. Such documentation is required from each fabricator employing a non-prequalified joint or procedure on the work. Failure to produce such documentation results in the fabricator being required to requalify the joint or procedure, or to use prequalified joints, procedures, and procedure specifications.

On weldments where geometric shape prevents compliance with requirements to weld a particular position, alternate procedures are considered for approval. Previously qualified alternate procedures are considered for approval without further procedure qualification tests. No separate payment is made for developing, demonstrating, and documenting for future use such alternate procedures, as such work is considered incidental to the work of welding.

(E) Requirements for Testing and Inspection

Require the fabricator to make provisions for convenient access to the work for inspection and cooperate with the inspector during the required inspection and testing.

Inspect welds in the presence of the Department's inspector unless otherwise approved by the Department's inspector, using visual inspection and the nondestructive tests herein prescribed in addition to the test requirements of the Bridge Welding Code and the contract documents. Employ quality control inspectors and NDT technicians qualified in accordance with the Bridge Welding Code and preapproved by the Engineer prior to the start of any fabrication. Supply the appropriate certifications as required by the Bridge Welding Code to the Department's inspector for all inspectors. Individuals assigned to production welding activities or processes and their supervisors are not acceptable for performing quality control testing. Have a qualified welding inspector present any time welding is in progress. No separate payment is made for inspection and testing. The entire cost of

this work is included in the unit contract price for the structural steel item(s) involved.

Retest welds requiring repairs or replacement in the presence of the Department's inspector after the repairs or replacements are made.

If the Engineer finds that acceptable repair to defective work is not feasible; the entire piece is rejected.

Payment at the contract prices for the various items in the contract which include the work of welding is full compensation for all costs resulting from the required nondestructive testing of welds and from the required inspection of welds.

(F) Nondestructive Test Required

The extent of nondestructive testing required is as prescribed in the Bridge Welding Code and by the contract documents except radiograph all flange splices for their full length. The term "main members" in this regard means girders, beams, floor beams, stringers, truss members, high strength bolts, columns, bearing stiffeners, bearing shoes, high mount lighting standards, and components of main member carrying stress, including the end connections for such members. Nondestructive testing of other complete welds or weld passes is required when so noted on the plans or deemed necessary by the Engineer. Tests other than those prescribed are also required when deemed necessary by the Engineer. Perform all radiographic testing in accordance with procedures established by the Engineer. Copies of these procedures are available from the State Materials Engineer.

Use edge blocks when radiographing butt welds greater than 1/2" in thickness. Use edge blocks with a length sufficient to extend beyond each side of the weld centerline for a minimum distance equal to the weld thickness, but not less than 2" and with a thickness equal to or greater than the thickness of the weld. Use edge blocks with a minimum width equal to half the weld thickness, but not less than 1”. Center the edge blocks on the weld with a snug fit against the plate being radiographed allowing no more than 1/16" gap. Produce edge blocks from radiographically clean steel and provide a surface finish of ANSI 125 or smoother.

High mount lighting standards longitudinal groove welds and fillet welds are radiographically tested as specified by the contract drawings. Other nondestructive test methods are sometimes deemed necessary by the Engineer to determine the quality of the welds. No separate payment is made for inspection and testing. The entire cost of this work is included in the unit contract price involved.

(G) Welded Structural Shapes

Produce butt welds of flanges and webs, and fillet welds of web to flanges of plate girders and haunched beams using the submerged arc process. Produce other structural shapes built up from plates and bars using the submerged arc process unless another process is qualified for these joints in accordance with the Bridge Welding Code and is subject to the approval of the Engineer.

After all shop welded splices in the flanges and webs for the full length of the field section are made, tested, and approved, fit the flange plates tight and square against the web so as to leave no gap and to not bow the web. Brace one side of each flange against the web with gussets or struts and tack weld securely to the web at the stiffener locations. Upon removal of the welds, grind any nicks or gouges, preheat, weld and test or incorporate into the stiffener fillet weld.

Connect the flanges to the web by starting the fillet weld at one end of the girder and proceeding to the other ends.

As an option, make adjacent welds simultaneously.

The sequence for making the flange to web fillet welds is subject only to the provisions for control of shrinkage and distortion and to the position requirements of the Bridge Welding Code.

After flange to web welds are complete, shift bracing gussets or struts if necessary, then remove all temporary gussets or struts. Remove tack welds by grinding flush with parent metal.

Straighten any transverse warpage of the flanges if necessary by heating along the centerline of the outside face.

Fit tight, square, and tack weld stiffeners securely to the web. With the girder in the flat position (web horizontal), weld the stiffeners to the web. Do not weld or tack weld stiffeners to the flanges except where noted on the plans.

After all parts are welded into place, trim the girder to detail length with adjustments for slope and end rotation exceeding 1/4" net.

1072-21 SHOP ASSEMBLING

(A) General:

Assemble the field connections of main members of continuous beam spans, plate girders, and rigid frames in the shop with milled ends of compressing members in full bearing, and then ream their sub-size holes to specified size while the connections are assembled. Assembly shall be either Full Girder Assembly or Progressive Girder Assembly unless Full Girder Assembly or Special Complete Structure Assembly is required by the contract.

Furnish a camber diagram to the Engineer showing the camber at each panel point of each continuous beam line, plate girder, or rigid frame. When the shop assembly is Full Girder Assembly or Special Complete Structure Assembly, have the camber diagram show the camber measured in assembly. When any of the other methods of shop assembly is used, show the calculated camber in the camber design.

Clean surfaces of metal in contact before assembling. Assemble the parts of a member, pin well, and firmly draw together with bolts before reaming. Take assembled pieces apart, if necessary, for removal of burrs and shavings produced by the reaming operation. Ensure that the member is free from twists, bends, and other deformation.

Drift during assembling only to bring the parts into position, and not sufficient to enlarge the holes or distort the metal. If any holes are enlarged to admit the fasteners, ream them.

Match-mark those connecting parts assembled in the shop for the purpose of reaming holes in field connections and provide a diagram showing marks furnished by the Engineer.

(B) Full Girder Assembly

Full Girder Assembly consists of assembling all members of each continuous beam line, plate girder, or rigid frame at one time.

(C) Progressive Girder Assembly

Progressive Girder Assembly consists of assembling initially for each continuous beam line or plate girder at least 2 contiguous shop sections or all members in at least 2 contiguous shop panels but not less than the number of panels associated with three contiguous section lengths (i.e., length between field splices) and not less than 150 feet in the case of structures longer than 150 feet. Add at least 1 shop section at the advancing end of the assembly before removing any member from the rearward end, so that the assembled portion of the structure is never less than the specified above.

(D) Special Complete Structure Assembly

Special Complete Structure Assembly consists of assembling the entire structure, including the floor system.

Have each assembly, including camber, alignment, accuracy of holes, and fit of milled joints, approved by the Engineer before reaming.

1072-22 PAINTING AND OTHER PROTECTIVE COATINGS

Shop paint in accordance with the requirements of Section 442.

Repair galvanized surfaces that are abraded or damaged in accordance with Article 1076-6.

1072-23 MARKING AND SHIPPING

Paint or mark each member with an erection mark for identification and furnish an erection diagram with erection marks shown thereon.

Furnish to the Engineer as many copies of material orders, shipping statements, and erection diagrams as the Engineer directs. Show the weights of the individual members on the statement. Mark the weights on members weighing more than 3 tons. Load structural members on trucks or cars in such a manner that they are transported, unloaded, and stored at their destination without being excessively stressed, deformed, or otherwise damaged.

Structural members shall be loaded on trucks or cars in such as manner that they may be transported to their destination without being excessively stressed, deformed or otherwise damaged.

Restrain overhanging ends of beams or girders both vertically and horizontally to prevent excess movement. Chains are permitted to secure beams and girders during shipping only when adequate measures are taken to prevent damage to the material by the use of approved protective material. If necessary, use adequate bracing to prevent bending of the top flange.

Pack bolts of one length and diameter and loose nuts or washers of each size separately. Ship pins, small parts, and packages of bolts, washers, and nuts in boxes, crates, kegs, or barrels, but do not allow the gross weight of any package to exceed 300 lbs. Plainly mark a list and description of the contained material on the outside of each shipping container.

Steel die stamped heat numbers, fabricator's identity, station number, girder number and span number of main members into an unpainted area (if available) near the end of the member. Die stamp members with painted ends outside the painted area but as close to the end as possible.

Steel die stamp the heat numbers of all major components of main members in the near end, near side of each girder in such a manner that the heat number is referenced to the appropriate component. Paint the heat number on the painted surface of the member along with the erection marks.

Ship anchor bolts, washers, and other anchorage or grillage materials, in time to be incorporated into the masonry portion of the structure.

SECTION 1074
MISCELLANEOUS METALS AND HARDWARE

1074-1 WELDING

Certify all welders performing any welding on any metals in accordance with the applicable AWS welding code in the position and process required as approved by the Engineer.

1074-2 EXPANSION ANCHORS

Unless otherwise shown on the plans, provide expansion anchors consisting of 2 or more units with a minimum of 2 hard metal conical ring wedges and 2 expandable lead sleeves of an equally effective design that is approved by the Engineer. Use anchors providing a minimum safe holding power of 3,000 pounds for 3/4" bolts and 2,000 pounds for 5/8" bolts, based upon 1/4 of the actual holding power of the anchor in 3,000 psi concrete. Furnish satisfactory evidence, based upon actual tests performed by a commercial testing laboratory, which indicate that the anchors develop the minimum required safe holding power.

When it is proposed to use anchors that are previously accepted as meeting the above requirements, the anchors are accepted on the basis of a certified statement indicating the prior acceptance of the furnished anchors.

1074-3 PLAIN STEEL BARS WITH THREADED ENDS

Provide plain steel bars with threaded ends meeting the requirements of AASHTO M183.

1074-4 HARDWARE FOR TIMBER STRUCTURES

Use machine bolts, drift-bolts, and dowels that are either wrought iron or medium steel. Use washers that are cast iron ogee, malleable iron castings, or cut from medium steel or wrought iron plate.

Use machine bolts with square heads and nuts. Use nails that are cut or round wire of standard form. Use spikes that are cut, wire spikes, or boat spikes.

Use black or galvanized nails, spikes, bolts, dowels, washers, and lag screws for untreated timber.

Galvanize or cadmium plate all hardware for treated timber bridges, except malleable iron connectors.

1074-5 METAL BRIDGE RAILING

(A) General

As an option, use either aluminum or galvanized steel metal rail, provided that the same material is used on all structures on the project.

Certified mill test reports are required for rails and posts.

Place a permanent identifying mark that identifies the fabricator on each post. Use a method and location of the identifying mark such that it does not detract from the appearance of the post.

Where it is necessary for rails to be curved, form the curvature in the shop or in the field. Uniformly curve the rail without buckling or kinking. Perform all welding in accordance with AWS D1.1 for steel railing and AWS D1.2 for aluminum railing.

Provide an anchor unit of sufficient strength to insure load anchoring capacity as specified for rail loading in the AASHTO *Standard Specifications for Highway Bridges*.

(B) Aluminum Rail

Supply material for posts, post bases, rails, expansion bars, and clamp bars meeting the requirements of ASTM B221 for alloy 6061-T6.

Use material for rivets meeting the requirements of ASTM B316 for alloy 6061-T6. Use rivets that are standard button head and cone point cold driven.

Use material for nuts meeting the requirements of ASTM B211 for alloy 6061-T6.

Provide material for washers meeting the requirements of ASTM B209 for alloy alclad 2024-T3.

Supply material for shims meeting the requirements of ASTM B209 for alloy 6061-T6.

Ensure that the handrails meet the dimensional tolerance requirements of ANSI H35.2.

(C) Galvanized Steel Rail

Use posts, post bases, rails, expansion bars, and clamp bars meeting the requirements of AASHTO M183 and galvanize in accordance with AASHTO M111. Grind the cut ends of rail smooth and give them 2 coats of organic zinc repair paint. Galvanize the posts and post bases after they are riveted together.

Use rivets meeting the requirements of ASTM A502 for Grade 1 rivets.

Use bolts meeting the requirements of ASTM F593 alloy 304.

Use nuts meeting the requirements of ASTM F594 alloy 304.

Use washers meeting the requirements of ASTM F844 except made from alloy 304 stainless steel.

Use materials for shims meeting the requirements of ASTM A570 for Grades 36, 40, or 45, or A611 for Grade C, and galvanized in accordance with AASHTO M111.

1074-6 STEEL PIPE

Steel pipe bent or welded in fabricating shall meet the requirements of ASTM A53 for standard weight pipe. Use galvanized pipe unless otherwise shown on the plans.

1074-7 IRON CASTINGS

(A) General

Boldly fillet castings at angles, and provide arrises that are sharp and perfect. No sharp, unfilleted angles or corners are permitted. Provide castings that are true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects affecting their strength and value for the service intended. Sand blast or otherwise effectively clean of scale and sand all castings to present a smooth, clean, and uniform surface. Welding is not allowed for the purpose of making a casting structurally sound. Welding for cosmetic or other purposes is not allowed without approval of the Engineer.

(B) Gray Iron Castings

Supply gray iron castings meeting the requirements of AASHTO M306. Proof load testing will only be required for new casting designs during the design process. Acceptance of production castings will be based on test bars. Cast test bars, of size "B", attached to and integral with the castings. In lieu of this, cast test bars separate from the castings when approved in writing by the Engineer. The Engineer reserves the right to require that a test bar be machined from an actual casting if deemed necessary. Unless otherwise specified, do not coat gray iron castings. Do not perform any welding on castings for any reason without prior approval from the Engineer. Mark castings with the NCDOT Standard Number of the casting design.

1074-8 STEPS

Fabricate steps for minor drainage structures from deformed reinforcing bars, use gray iron castings meeting the requirements of Subarticle 1074-7(B), or use composite plastic-steel construction as shown on the plans.

The use of steps differing in dimension, configuration, or materials from those shown on the plans is allowed by furnishing the Engineer with details of the proposed steps and obtaining written approval for the use of such steps.

1074-9 FABRICATED STEEL GRATES

Use fabricated steel grates made from bars that meet the requirements of AASHTO M183. Galvanize the grates after fabrication in accordance with AASHTO M111.

1074-10 PINS

Supply pins for bearing assemblies meeting the requirements of either AASHTO M183 or AASHTO M169 for grades 1016 through 1030, unless otherwise required by the plans or specifications.

1074-11 WASHERS

Provide washers for use with fasteners meeting the requirements of AASHTO M293M. Provide washers for high strength bolts meeting the requirements of Article 1072-7.

Ensure that the size and finish (plain, weathering, or galvanized) of washers is compatible with the fastener.

1074-12 METAL STAY-IN-PLACE FORMS

Provide metal stay-in-place forms for concrete floor slabs of zinc-coated (galvanized) steel sheet conforming to ASTM specification A653 (Structural Steel (SS) Grade 33 through 80) with coating class of G165 meeting all requirements relevant to steel stay-in-place forms as noted on the contract plans. Do not use material thinner than 20 gage.

SECTION 1076
GALVANIZING

1076-1 GALVANIZING

Wherever galvanizing is required, perform the galvanizing in accordance with this section of the Specifications except where other requirements for galvanizing are included in other sections of the specifications.

1076-2 FABRICATED PRODUCTS

Galvanize products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strips, 1/8" thick and heavier in accordance with AASHTO M111. Fabricate products into the largest unit that is practicable to galvanize before the galvanizing is done. Fabrication includes all operations necessary to complete the unit such as shearing, cutting, punching, forming, drilling, milling, bending, welding, and riveting. Galvanize components of bolted or riveted assemblies separately before assembly. When it is necessary to straighten any sections after galvanizing, perform such work without damage to the zinc coating.

Completely seal all edges of tightly contacting surfaces by welding before galvanizing.

Commercial blast clean components with partial surface finishes in accordance with Subarticle 442-8(A) prior to pickling.

1076-3 HARDWARE

Galvanize iron and steel hardware in accordance with AASHTO M232.

1076-4 ASSEMBLED PRODUCTS

Galvanize assembled steel products in accordance with AASHTO M111.

Completely seal all edges of tightly contacting surfaces by welding before galvanizing.

1076-5 SHEETS

Galvanize iron or steel sheets in accordance with ASTM A653.

1076-6 REPAIR OF GALVANIZING

Repair galvanized surfaces that are abraded or damaged at any time after the application of zinc coating by thoroughly wire brushing the damaged areas and removing all loose and cracked coating, after which paint the cleaned areas with 2 coats of organic zinc repair paint meeting the requirements of Article 1080-9. Ensure that the total thickness of the 2 coats is not less than 3 dry mils. In lieu of repairing by painting with organic zinc repair paint, other methods of repairing galvanized surfaces that are abraded or damaged are allowed provided the proposed method is acceptable to the Engineer.

Excessive damage to galvanized surfaces as determined by the Engineer is cause for rejection. Replace or re-galvanize rejected galvanized material.

SECTION 1077
PRECAST CONCRETE UNITS

1077-1 GENERAL

Use precast concrete units from sources participating in the Department's Precast Concrete Quality Control/Quality Assurance Program. A list of participating sources is available from the Materials and Tests Unit's Central Laboratory. The Department will remove a manufacturer of precast concrete units from this program in the event that the monitoring efforts indicated that non-specification material is being provided or test procedures are not being followed.

This section covers the materials for and the production of precast reinforced concrete units produced in accordance with the contract.

Where precast reinforced concrete circular manhole sections are used, they shall meet the requirements of AASHTO M199 in addition to the requirements of this section.

1077-2 PLAN REQUIREMENTS

The plans for precast units will be standard drawings or details shown in the project plans, furnished by the Department.

When the Department does not make precast plans available and the Contractor chooses to precast, submit drawings to the Engineer for the items proposed to precast. Submit one

complete set of drawings for review, at least 40 calendar days prior to precasting. After acceptance, submit 7 complete sets of drawings. Acceptance by the Engineer of contractor drawings will not be considered as relieving the Contractor of any responsibility for precast units. When precast units are load bearing and require structure design, have the plans prepared and certified by a North Carolina Registered Professional Engineer. Contractor furnished drawings shall show complete design, installation, and construction information in such detail as to enable the Engineer to determine the adequacy of the proposed units for the intended use. Contractor drawings shall also include details of steel reinforcement size and placement and a schedule that lists the size and type of precast units at each location where the precast units are to be used. Produce precast units in accordance with the approved drawings.

1077-3 MATERIALS

All materials shall meet the requirements of Division 10 shown below:

Item	Section
Coarse Aggregate	1014-2
Fine Aggregate	1014-1
Portland Cement	1024-1
Type IP Blended Cement	1024-1
Fly Ash	1024-5
Water	1024-4
Type IS Blended Cement	1024-1
Ground Granulated Blast Furnace Slag	1024-6
Silica Fume	1024-7
Air Entraining Agent	1024-3
Chemical Admixtures	1024-3
Reinforcing Steel	1070
Miscellaneous Metals	1074
Curing Agents	1026

1077-4 INSPECTION

The Department reserves the right to place a duly authorized inspector in the plant at any time work related to the production of units for the Department is being performed. Notify the Engineer at least 7 days in advance when such work is scheduled to begin.

Provide an office area for the inspector of at least 50 square foot with desk, chair, telephone, facilities for proper heating and cooling, adequate lightning and electrical outlets.

Acceptance of precast units will be on the basis of tests of materials, compression tests on concrete cylinders, and inspection of the finished units, including amount and placement of steel reinforcement, to determine their conformance with the approved dimensions and design and their freedom from defect. The inspector will have the authority to reject any or all units not manufactured in accordance with these specifications. Any unit found to be defective in any manner at any time will be rejected and replaced by an acceptable unit or repaired in a manner approved by the Engineer.

(A) Storage

Store all Department units in a separate area on the yard. Store all units on a solid, unyielding foundation free of standing water or in a manner directed by the Engineer. Do not stack units prior to inspection.

(B) Transporting

Do not transport units away from the casting yard until the concrete has reached the minimum required 28 day compressive strength and a period of at least 5 days elapses after casting, unless otherwise permitted by the Engineer.

Do not transport any unit from the plant to the job site prior to the approval of that unit by the plant inspector. Such approval is stamped on the unit by the plant inspector.

1077-5 PORTLAND CEMENT CONCRETE

(A) Composition and Design

Portland cement concrete is composed of portland cement, coarse aggregate (#67 or 78M), fine aggregate, water, and, unless otherwise permitted by the Engineer, an air entraining agent. If other cementitious materials and/or chemical admixtures are used, use these materials in the proper proportions to obtain the optimum effect. Do not use calcium chloride, or other admixtures containing calcium chloride.

Supply concrete that develops a minimum compressive strength as shown in Table 1077-1 unless other strengths are designated on the approved drawings. When required, air entrain concrete to provide an air content of 4.5 percent, plus or minus 1.5 percent. Supply concrete with a maximum slump of 3 1/2" unless a high range water reducer (super plasticizer) is approved by the Engineer. Do not use concrete with a slump exceeding 6.0". As an option, reduce the cement content of the mix design by up to 20% and replace with fly ash at a rate of 1.2 pounds of fly ash for each pound of cement replaced or reduce the cement content up to 50% and replace with blast furnace slag on a pound for pound basis.

Submit a proposed concrete mix design for the precast units. Determine quantities of fine and coarse aggregates necessary to provide concrete meeting the requirements of the specifications by the method described in ACI 211, *Recommended Practice For Selecting Proportions For Normal Weight Concrete*, using the absolute volume method.

The Engineer will review the mix design only to ascertain general compliance with Specification requirements. Do not use a mix until notified that the mix is acceptable. Acceptance of the mix design does not relieve the Contractor of his responsibility to furnish an end product meeting specification requirements. Upon request from the Contractor, a precast concrete unit mix design accepted and used satisfactorily on any Department project may be accepted for use on other projects.

TABLE 1077-1

PRECAST CONCRETE STRENGTH REQUIREMENTS (AT AN AGE OF 28 DAYS)

PRECAST UNIT		SPECIFICATION REFERENCE
	Psi	
BARRIER		
Used Portable	3500	Sect. 1090 & 1170
New Portable	4500	Sect. 854, 1090, & 1170
Permanent	4500	Sect. 854, 857, & 1090
CULVERTS		
Circular Pipe	4000	Sect. 310, 1032, 1034, 1520, & AASHTO M170
Single Cell Box Sections	5000	Contract & AASHTO M259
Flared End Sections	3500	Sect. 310 & 1032
Pipe Tees	4000	Sect. 310, 1032, & AASHTO M170
Pipe Elbows	4000	Sect. 310, 1032, & AASHTO M170
Cross & Parallel Special End Sections	3500	Sect. 310 & 1032
DRAINAGE STRUCTURES		
Boxes (Solid & Waffle)	4000	Sect. 840 & ASTM C913
CIRCULAR MANHOLES		
Base	4000	Sect. 1525 & AASHTO M199
Riser Section	4000	Sect. 1525 & AASHTO M199
Top Section	4000	Sect. 1525 & AASHTO M199
Grade Ring	4000	Sect. 858 & AASHTO M199
Noise/Sound, Wing, Head & End Walls	4000	AASHTO M199
Concrete Pads For Outlet Pipe	2500	Sect. 815, 816, & 825
Right Of Way Markers	2500	Sect. 806 & 1054
MISCELLANEOUS ITEMS		
Concrete Anchor For Cable Guardrail	3000	Sect. 1046
Picnic Tables	2500	Contract
Waste Containers	2500	Contract

** Strength varies by Class.

(B) Testing

Make all representative concrete test cylinders and all testing required by this subarticle in the presence of the plant inspector unless otherwise approved by the Engineer.

Before the first load is placed, determine the air content by a calibrated Chace Indicator, AASHTO T199. If the air content as determined by the Chace indicator fails to meet the specification requirements, perform 2 more tests with the Chace indicator on the same load and all 3 tests are averaged. Acceptance or rejection of the load is based on the average of the 3 Chace indicator tests. As an alternate method determine the air content by AASHTO T152, T196, or T121.

Perform temperature, air and slump tests whenever cylinders are cast.

Determine slump in accordance with AASHTO T119 with a maximum of 3 1/2" allowed.

For the purpose of testing for the required 28 day compressive strength, furnish, at no cost to the Department, a minimum of 4 concrete cylinders for each class of concrete, each structure, and each day that precast units are produced for the Department. If the contractor anticipates an early break request, furnish the Department with 2 concrete cylinders for each early break request. These cylinders are in addition to the 4 concrete cylinders required for each day of production. Make and cure cylinders in accordance with AASHTO T23 unless, by permission of the Engineer, the units are cured by one of the methods in Article 1077-9 for the full time required to meet the specified compressive strength requirements. In such case, cure the cylinders with the members and in the same manner as the members. Test cylinders in accordance with AASHTO T22. If the average of 2 cylinders tested to determine compressive strength at the age of 28 days fails to indicate a compressive strength as shown in Table 1077-1, or such compressive strength as is required by the approved drawings, such failure is cause for the rejection of the members represented.

(C) Temperature requirements

Maintain the concrete temperature at the time of placing in the forms not less than 50°F nor more than 95°F unless otherwise directed by the Engineer.

Place concrete in cold weather in accordance with the requirements of Article 420-9.

(D) Use of Water Reducing Admixtures

Use water reducing admixtures in accordance with Subarticle 1000-4(G).

Use high range water reducers (super plasticizers) if approved by the Engineer.

1077-6 FORMS

Use forms of sturdy construction and which are capable of consistently providing straight lines and uniform dimensions in the finished product. Use metal forms except where other materials are approved by the Engineer. Provide an identifying number on each form, and mark each precast unit with the same identifying number as the form used to cast unit. Forms not meeting these requirements are subject to rejection by the Engineer.

Provide joints in forms that are smooth and tight enough to prevent leakage of mortar. Provide inside surfaces of forms that are accessible for cleaning. After each use, clean the forms thoroughly. Prior to casting, free the inside surfaces of the forms from rust, grease, or other foreign matter. Do not allow coatings used for release of members to build up and in no case allow liquid or powder from coating materials to come in contact with the reinforcement steel.

1077-7 REINFORCEMENT

Furnish reinforcement and place as shown on the plans and in accordance with the requirements of Section 425. Stockpile domestic and foreign steel in separate locations.

1077-8 PLACING CONCRETE

Use the procedures and equipment for handling, placing, and consolidating the concrete such that a uniformly dense and high grade concrete is obtained in all parts of the unit under all working and weather conditions. Do not mix, handle, deliver, place, or finish concrete using devices made of aluminum or containing aluminum.

Internal, external, or a combination of internal and external vibration is required as necessary to produce uniformly dense concrete without honeycomb.

1077-9 CURING CONCRETE

(A) General

Precast units are subjected to one of the methods of curing described below or to other methods or combinations of methods approved by the Engineer. Cure the precast units for a sufficient length of time so that the concrete develops the specified compressive strength at 28 days or less. Do not strip forms until at least 24 hours after the concrete attains initial set. For this purpose, initial set is defined as at least 500 psi resistance to a standard penetrometer. The option to strip forms earlier is available provided concrete cylinders indicate a strength of at least 75% of the 28 day compressive strength is attained prior to release for each day's production. Do not deface or injure the units.

(B) Curing at Elevated Temperatures

Cure at elevated temperatures in accordance with the requirements of Subarticle 1078-10(B).

(C) Water Curing

Water curing of precast units is allowed as described in Article 420-16 B, by covering with water saturated material, or by a system of perforated pipes, mechanical sprinklers, porous hoses, or by any other method that keeps the units moist during the specified curing period. Do not use methods that deface or injure the precast units.

(D) Curing Compound

Application of a curing compound is allowed provided it is left intact until the specified compressive strength is met. Keep all surfaces moist prior to the application of the compound and damp when the compound is applied. Seal the

surface with a single uniform coating at the rate of coverage recommended by the curing compound manufacturer, or as directed by the Engineer, but not less than 1 gallon per 150 square feet of area.

1077-10 LIFT HOLES, HANDLING

Do not cast or drill more than 4 holes in each unit for the purpose of handling or placing unless otherwise approved by the Engineer. Locate all lift holes and handling devices in accordance with plan and design requirements. Units damaged while being handled or transported are rejected or require repair in a manner approved by the Engineer.

1077-11 FINAL FINISH

Unless otherwise required by the contract, finish all concrete in accordance with Subarticle 420-18(B).

Do not repair units with honeycomb, cracks, or spalls until inspected by the Engineer. Use repair methods that are approved by the Engineer prior to their use. Any appreciable impairment of structural adequacy is cause for rejection.

1077-12 STEPS FOR PRECAST DRAINAGE STRUCTURES

Supply steps meeting the requirements of AASHTO M199 for design, materials, and dimensions. Incorporate steps in all drainage structures over 3'-6" in height. Do not detail the lowest step more than 16" from the bottom.

1077-13 MARKING

Clearly show the following information on each precast member:

(A) Date of manufacture.

(B) Name of the manufacturer.

(C) Piece mark designations where such designations are shown on the plans.

(D) For precast culverts, match mark each precast member by a method approved by the Engineer, prior to shipment.

Indent marking into the concrete or paint on with waterproof paint.

1077-14 DIMENSIONS

Ensure that all dimensions allow assembly of the units in place without objectionable deviation from the lines shown on the plans. If requested by the Engineer, assemble the precast members to ensure a quality fit prior to shipment of the precast members.

SECTION 1078
PRESTRESSED CONCRETE MEMBERS

1078-1 GENERAL

This section covers the materials for and the production of precast, prestressed concrete members produced in accordance with the contract.

Use prestressing of the pretensioning type in which steel prestressing strands are initially stressed and anchored; the concrete is then placed, vibrated, and cured; and when the concrete reaches the required strength, the load is transferred from the anchorages to the concrete.

1078-2 MATERIALS

Use materials meeting the requirements of Division 10 shown below:

Item	Section
Coarse Aggregate	1014-2
Fine Aggregate	1014-1
Portland Cement	1024-1
Type IP Blended Cement	1024-1
Fly Ash	1024-5
Water	1024-4
Air Entraining Agent	1024-3
Chemical Admixtures	1024-3
Reinforcing Steel	1070
Prestressing Strand	1070-5
Structural Steel	1072
Miscellaneous Metals	1074
Type IS Blended Cement	1024-1
Ground Granulated Blast Furnace Slag	1024-6
Silica Fume	1024-7
Epoxy Protective Coating	1081-1

Do not make changes in the source of aggregates, cements, or admixtures during the casting of members in any one span or substructure unit unless approved by the Engineer.

1078-3 INSPECTION

The Department reserves the right to place a duly authorized inspector in the plant at any or all times work related to the production of members for the Department is performed. Notify the Engineer at least 7 days in advance when such work is scheduled. Provide an office area with an approximate floor space of 100 square feet, a desk or drafting table, 2 chairs, telephone, separate dial-up or faster internet access, facilities for proper heating and cooling, and adequate lighting at the plant for the exclusive use of the inspector. The inspector has the authority to reject any or all members not manufactured in accordance with these Specifications. Approval of any member by the inspector at the plant, however, is in no way final, and further inspection is made at the structure site both before and after the member is placed in the final position. Any member found to be defective in any manner at any time is rejected and requires replacement by an acceptable member or repair in a manner approved by the Engineer.

Do not transport any member from the plant to the job site prior to approval of that member by the plant inspector. Provide access to all surfaces of the member so that the plant inspector has the opportunity to properly inspect the member prior to approval. This approval is stamped on the member by the plant inspector.

1078-4 PORTLAND CEMENT CONCRETE

(A) Composition and Design

Supply portland cement concrete composed of portland cement, coarse aggregate, fine aggregate, water, and an approved air-entraining agent. Add other cementitious materials and/or chemical admixtures if approved by the Engineer. When admixtures are used, use them in the proper proportions to obtain the optimum effect. Do not use set accelerating admixtures, calcium chloride, or admixtures containing calcium chloride. If approved, high range water reducer may be used at a rate not to exceed the manufacturer's recommended dosage.

Supply concrete with a minimum compressive strength of 5,000 psi at the age of 28 days, unless otherwise required by the plans or Specifications. Ensure that all coarse aggregate used in prestressed concrete passes a 1" sieve. Maintain a cement content of at least 564 lbs. but no more than 752 lbs. per cubic yard. As an option, reduce the cement content of the mix design and replace with fly ash or ground granulated blast furnace slag in accordance with Subarticle 1024-1(A). For concrete with a 28 day design strength greater than 6,000 psi, if approved, substitute microsilica for cement, in conformance with Subarticle 1024-1(A).

Supply concrete meeting the requirements of Table 1078-1, unless otherwise approved by the Engineer.

TABLE 1078-1
REQUIREMENTS FOR CONCRETE

	28 Day Design Compressive Strength 6,000 psi or less	28 Day Design Compressive Strength greater than 6,000 psi
Maximum Water/Cementitious Material Ratio	0.45	0.40
Maximum Slump without HRWR	3.5"	3.5"
Maximum Slump with HRWR	7"	7"
Air Content (upon discharge into forms)	5 $\pm$ 2%	5 $\pm$ 2%

Submit to the Engineer proposed concrete mix designs for each strength of concrete used in the work. Determine quantities of fine and coarse aggregates necessary to provide concrete meeting the requirements of the specifications by the method described in ACI211, "Recommended Practice for Selecting Proportions for Normal Weight Concrete", using the absolute volume basis.

Submit mix designs, stated in terms of saturated surface dry weights, on M&T Form 312 at least 35 days prior to using the proposed mix. Adjust batch proportions to compensate for surface moisture contained in the aggregates at the time of batching. Changes in the saturated dry mix proportions are not permitted unless revised mix designs are submitted to the Engineer and are determined to be acceptable for use.

Provide with Form 312 a listing of laboratory test results of aggregate gradation, air content, slump, and compressive strength. List the compressive strength of at least three 6"x12" or 4"x8" cylinders. Show the age of the cylinders at the time of testing and a detailed description of the curing procedure. Perform laboratory tests in accordance with the following test procedures:

Aggregate Gradation	-- AASHTO T27
Air Content	-- AASHTO T152
Slump	-- AASHTO T119
Compressive Strength	-- AASHTO T23 and T22

If the design 28 day compressive strength is greater than 6,000 psi, submit the compressive strength of at least six cylinders. Ensure that the average strength of the six cylinders is at least 1,500 psi above the minimum 28 day compressive strength required by the plans.

When the combination of materials is such that the required strength and/or a workable slump is not obtained at the minimum specified cement content with the maximum allowable water-cement ratio, increase the cement content at no cost to the Department by whatever amount is required to produce the required strength and/or slump without exceeding the allowable water-cement ratio.

The Engineer reviews the mix design only to ascertain general compliance with Specification requirements. The Engineer notifies the Contractor, in writing, that the mix design is either acceptable or unacceptable. Do not use a mix until notified by the Engineer that the mix design is acceptable. Acceptance of the mix design does not relieve the Contractor of responsibility to furnish an end product meeting specification requirements. Upon request, a mix design accepted and used satisfactorily on any Department project may be accepted for use on other projects.

(B) Testing

Employ a certified concrete technician to perform all testing required by this subarticle at the bed site in the presence of the plant inspector unless otherwise approved. Certification of technicians is awarded upon satisfactory completion of examinations prepared and administered by the Division of Highways or other approved agency.

(1) Air Content

Before allowing placement of the first load in a bed, determine the air content by a calibrated Chace indicator, AASHTO T199. During the placement of the first load, determine the air content by AASHTO T152, T196, or T121. Determine the air content in each subsequent 10 cubic yards by the Chace indicator, AASHTO T199, prior to allowing placement. Determine the air content by AASHTO T152, T196, or T121 from all loads from which cylinders are made. If the air content as determined by the Chace indicator, AASHTO T199, fails to meet the specification requirements, a second test is run on material from the same load and the results of the 2 tests averaged. If

the average does not meet the Specification requirements, a test on the same load is conducted using AASHTO T152, T196, or T121. Acceptance or rejection of the load is based on the results of this test.

(2) Slump

Determine slump in accordance with AASHTO T119.

(3) Strength

For the purpose of testing for the required 28 day compressive strength and also for the required compressive strength for the transfer of load, furnish, at no cost to the Department, cylinders made from a sample of concrete placed near the live end of the bed and additional cylinders made from a sample of concrete placed near the dead end of the bed. Make cylinders in accordance with AASHTO T23, except cure the cylinders in the same manner as the members represented until the strands are released. Place cylinders in clusters at random points along the casting bed. After the strands are released, air cure the cylinders in an approved common area near the testing apparatus for the remainder of the 28 day curing period. Test the cylinders in accordance with AASHTO T22. Provide approved apparatus for testing the transfer strength of the cylinders. Maintain this apparatus to within 1.0 percent accuracy and calibrate at intervals not to exceed 12 months by an approved testing company at no cost to the Department. The Engineer reserves the right to require verification immediately after a testing machine is relocated and whenever there is reason to doubt the accuracy of the indicated load, regardless of the time interval since the last verification.

The testing requirements vary according to the 28 day compressive strength required by the plans as follows:

(a) Compressive Strength (28 day) of 6,000 psi or Less

Test two cylinders, one from each end of the bed, for the purpose of determining whether the concrete has reached the required strength for transfer of load. Ensure that the average of the strength tests on the two cylinders meets or exceeds the required strength and the lowest cylinder is not more than 200 psi below the required strength.

Test two cylinders to determine compressive strength at the age of 28 days. The strength from these two cylinders is averaged. Ensure that this average is at least 5,000 psi or such 28 day compressive strength required by the plans or Specifications. Ensure that no cylinder indicates a compressive strength less than 400 psi below the required 28 day compressive strength. Failure to meet the above requirements is cause for rejection of the members represented.

(b) Compressive Strength (28 day) of greater than 6,000 psi

Test four cylinders, two from each end of the bed, for the purpose of determining whether the concrete has reached the required strength for transfer of load. The strengths from the dead end cylinders are averaged and the strengths from the live end cylinders are averaged. Ensure that both of

these averages meet or exceed the required release strength and the lowest cylinder is not more than 200 psi below the required strength.

Test three cylinders from each end to determine the 28 day compressive strength. The strengths from the dead end cylinders are averaged and the strengths from the live end cylinders are averaged. Ensure that both of these averages meet or exceed the 28 day compressive strength. Ensure that no cylinder indicates a compressive strength less than 400 psi less than the required 28 day compressive strength. Failure to meet the above requirements is cause for rejection of the members represented.

(C) Temperature Requirements

Maintain a concrete temperature at the time of placing in the forms between 50°F and 95°F.

Do not place concrete when the air temperature, measured at the location of the concreting operation in the shade away from artificial heat, is below 35°F.

(D) Elapsed Time for Placing Concrete

Ensure that the elapsed time for placing concrete is in accordance with Subarticle 1000-4(E). The requirements of Subarticle 1000-4(E) pertaining to Class AA concrete also apply to prestressed concrete.

(E) Use of Set Retarding Admixtures

By permission of the Engineer, use an approved set retarding admixture if choosing to take advantage of the extended time interval between adding mixing water and placing the concrete.

Use a quantity of set retarding admixture per 100 lbs. of cement within the range recommended on the current list of approved set retarding admixtures issued by the Materials and Tests Unit.

(F) Use of Water Reducing Admixtures

Use water-reducing admixtures in accordance with Subarticle 1000-4(G).

(G) Use of Calcium Nitrite Corrosion Inhibitor

Add an approved calcium nitrite corrosion inhibitor (30% solids) to the concrete mix at the batch plant for the bridge elements identified by the plan notes. Clearly mark the prestressed concrete members that contain calcium nitrite.

Use the inhibitor at a minimum rate of 3.0 gal/yd^3. Ensure that the hardened concrete contains at least 5.1 lbs/yd^3 Nitrite (NO_2) when tested in accordance with Materials and Tests Method Chem. C-20.0 with the exception of concrete used in prestressed members. Test prestressed members as follows:

The Department will perform the complete *C-21.0 Field Test Procedure for the Nitrite Ion in Plastic Concrete* on plastic concrete samples obtained randomly from a truck used to pour concrete near each end (live end and dead end) of a prestressed concrete casting. Powder samples will be taken from hardened cylinders made at the time C-21.0 is run for any concrete that fails the C-21.0 (plastic test) method. The

Chemical Testing Laboratory will test the powder using method *C-20.0 Determination of Nitrite in Hardened Concrete*. Acceptance of the concrete is dependent in the results of method C-20.0 (hardened test) when any sample fails the C-21.0 (plastic test method).

The Department will perform a qualitative nitrite ion check by method C-22.0 (Field Spot Test) on each load of concrete batched for a prestressed concrete casting bed. Acceptance of the concrete is dependent on the results of method C-20.0 (hardened test) when any sample fails the C-22.0 (Field Spot Test). The producer may elect to not incorporate concrete that fails Method C-22.0 (Field Spot Test) in lieu of waiting for C-20.0 (hardened test) test results to determine the acceptability of the member. Once per each week's production of prestressed concrete with corrosion inhibitor, random samples of hardened concrete powder will be taken from cylinders used for method C-21.0 (plastic test). These samples will be submitted to the Chemical Testing Laboratory for analysis using method C-20.0 (hardened test).

Units with calcium nitrite in a quantity less than specified are subject to rejection. Furnish concrete cylinders to the Engineer, in a quantity to be specified, to verify the concentrations of calcium nitrite in hardened concrete. Concrete failing to contain calcium nitrite at the required concentrations as tested is subject to rejection.

Use only air-entraining, water-reducing, and/or set-controlling admixtures in the production of concrete mixtures that are compatible with calcium nitrite solutions.

Strictly adhere to the manufacturer's written recommendations regarding the use of admixtures including storage, transportation and method of mixing. If preferred, use calcium nitrite, which acts as an accelerator, in conjunction with a retarder to control the set of concrete, as per the manufacturer's recommendation.

(H) Measuring Materials

Measure materials in accordance with Article 1000-9.

(I) Mixers and Agitators

Use mixers and agitators meeting the requirements of Article 1000-10.

(J) Mixing and Delivery

(1) General

Mix and deliver concrete to the site of the work by means of one of the following methods, except where other methods are approved by the Engineer. The Engineer approves the mixing of concrete by methods other than those listed below provided the proposed method is capable of satisfying job requirements and there is adequate evidence that the proposed method produces concrete complying with Specification requirements. Assume responsibility for controlling the materials and operations in such a manner as to produce uniform concrete meeting Specification requirements.

Have present during all batching operations at the concrete plant a certified concrete technician employed by the Contractor, prestressed concrete producer, or concrete supplier while concrete is batched and delivered to the

site of the work. The sole duty of this employee is to have charge of and exercise close supervision of the production and control of the concrete. Have the technician perform moisture tests, adjust mix proportions of aggregates for free moisture, complete batch tickets (M & T Form 903) or approved delivery tickets, sign batch tickets or approved delivery tickets, and assure quality control of the batching operations. Delivery tickets are permitted in lieu of batch tickets (M & T Form 903) provided they are reviewed and approved by the Materials and Tests Unit. Certification of technicians is awarded upon satisfactory completion of examinations prepared and administered by the Division of Highways or other approved agency.

(a) Central Mixed Concrete

Mix completely in a stationary mixer and transport the mixed concrete to the point of delivery in a truck agitator or in a truck mixer operating at agitating speed or in non-agitating equipment approved by the Engineer. Mix within the capacity and at the mixing speeds recommended by the equipment manufacturer.

(b) Transit Mixed Concrete

Mix completely in a truck mixer while at the batching plant, in transit, or at the work site.

(2) Mixing Time for Central Mixed Concrete

The mixing time starts when all the solid materials are in the mixing compartment and ends when any part of the concrete begins to discharge. Charge the ingredients into the mixer such that some of the water enters in advance of cement and aggregate, and substantially all the water is in the drum before one-third of the specified mixing time elapses. Transfer time in multiple drum mixers is counted as part of the mixing time.

Establish the minimum mixing time by either:

(a) Mixer performance tests as described in this subarticle,

(b) The manufacturer of the equipment,

(c) The requirement of 1 minute for mixers of 1 cubic yard capacity or less with an increase of 15 seconds for each cubic yard or fraction thereof in increased capacity.

The Engineer reserves the right to require a mixer performance test at any time. The minimum mixing time as determined by the mixer performance test is that which produces concrete meeting the requirements of Table 1078-2.

Sample and test for mixer performance as provided below. Charge the mixer to its rated capacity with the materials and proportions used in the work and mix at the recommended mixing speed to the target time. Stop mixing then and begin discharging. Take two samples of sufficient size to make the required tests after discharge of approximately 15 and 85 percent of the load

by an appropriate method of sampling which provides representative samples of the concrete.

Separately test each of the 2 samples of concrete for the properties listed in Table 1078-2. Conduct tests in accordance with the standard methods shown in Table 1078-2 or procedures established by the Materials and Tests Unit.

Perform the mixer performance test described above on a minimum of 2 batches of concrete. For the performance test to be acceptable, ensure that all tests in each batch meet the requirements listed above.

The Engineer rechecks mixer performance at any time when in his judgment acceptable mixing is not accomplished.

Where acceptable mixing cannot be accomplished in the established mixing time, the Engineer increases the mixing time or requires that the mixer be repaired or replaced before any further mixing.

(3) Truck Mixers and Truck Agitators

Use truck mixers and truck agitators meeting the requirements of Subarticle 1000-11(C). For concrete with a design 28 day compressive strength greater than 6,000 psi, load trucks to within 1 $yd.^3$ of rated capacity and mix at a speed of 16 – 18 revolutions per minute.

(4) Delivery

For central mixed concrete delivered in truck agitators, truck mixers, or transit mixed concrete, use a ticket system for recording the transportation of batches from the proportioning plant to the site of the work. Fill out the tickets (M & T Form 903) or approved delivery tickets in accordance with the instructions issued by the Engineer. Issue the tickets to the truck operator at the proportioning plant for each load and have them signed by the certified concrete technician, which signifies that the concrete in the truck is inspected prior to departure. Show on each ticket the time batching is complete and if transit mixed, the number of revolutions at mixing speed, if any, at the plant. Deliver the tickets to the inspector at the site of the work. For central mixed concrete delivered in non-agitating equipment, alternate methods of documenting batch proportions are considered by the Engineer. Loads that do not arrive in satisfactory condition within the time limits specified are not acceptable for use in the work.

(K) Ready Mixed Concrete Plant

Have ready mixed concrete plants inspected and approved by the Department before they are used to produce concrete for the project. Ensure that plants meet all applicable requirements of the Specifications and in addition have at least 2 acceptable concrete delivery vehicles that are in working condition. Plants approved by the Department are placed on a list of approved plants that is made available. All plants are subject to reinspection at intervals selected by the Engineer.

Reapproval after each inspection is contingent on continuing compliance with the Specifications.

TABLE 1078-2
REQUIREMENTS FOR UNIFORMITY OF CONCRETE WITHIN A BATCH

Tests	Maximum Permissible Difference in Test Samples
Air content, percent by volume of concrete AASHTO T152)	1.0%
Slump, inches (AASHTO T119)	1.0"
Coarse aggregate content, portion by weight of each sample retained on the No. 4 sieve, percent	6.0%
Weight per cubic foot (AASHTO T121)	1.0 lb.
Average compressive strength at 7 days, percent of average (AASHTO T22 and T23)	7.5%*

* Obtain tentative approval pending 7 day compressive strength tests.

1078-5 CASTING BED AND FORMS

Use metal forms, including headers or end forms, except where other materials are approved by the Engineer. Use forms of adequate thickness, braced, stiffened, anchored, and aligned adequately to consistently produce members within the limits of dimensional tolerances. Design and align the forms so they do not restrict longitudinal movement of the casting when the prestressing force is transferred. Provide corners and angles that are chamfered or rounded. Provide joints in forms that are smooth and tight enough to prevent leakage of mortar. Plug holes and slots in forms, pallets, headers, and bulkheads neatly to prevent leakage of mortar. Make the inside surfaces of forms accessible for cleaning. Thoroughly clean the beds and forms after each use. Prior to casting, clean the inside surfaces of the forms from rust, grease, or other foreign matter. Remove all foreign substances from inside the forms, including any standing water. Do not allow coatings used for release of members to build up. Do not use forms that do not present a smooth surface.

When casting holes through the top flange of Bulb Tee Girders for overhang or interior bay falsework hanger rods, use rigid PVC conduits with a wall thickness of approximately 1/8". Do not use thin wall material. Secure conduits in the forms so that they do not migrate out of the proper location. Other methods of forming holes may be proposed but are subject to the Engineer's approval.

When casting dowel rod holes in cored slab or box beam members, use material that creates round, vertical holes of the specified diameter and in the correct location. Do not use material that deforms, collapses or shifts position during casting of the member.

Apply form release agents to the forms either before or after stringing of strands. If applied prior to stringing, provide a release agent of a type that dries to a degree so that it cannot contaminate any strand that comes in contact with it. If the release agent is applied after stringing, exercise great care and provide a sheet metal or similar type shield for protection of the strands.

1078-6 TENSIONING DEVICES

Use tensioning devices adequate to produce and maintain the required tension in all strands until the concrete reaches the required transfer strength. Equip all jacks with accurate and calibrated gages for registering jacking loads. Calibrate gages with the jacks with which they are used. Calibrate all jacks and gages by an approved testing company at no cost to the Department at intervals not to exceed 12 months. During progress of the work, if gage readings and elongations indicate materially differing loads, recalibrate as required. Use gages with a full load capacity of 1 1/2 to 2 times their normal working load, unless otherwise approved. Do not use loads less than one-fourth or more than three-fourths of the total graduated gage capacity unless calibration data clearly establishes consistent accuracy over a wider range. Use gages with indicating dials at least 6" in diameter and gage pointers that do not fluctuate, preventing an accurate reading, but remain steady until the jacking load is released. Ensure that all gages have an accuracy of reading within 2 percent. Provide means for measuring the elongation of strands within 1/4".

1078-7 PLACING STRANDS, TIES, AND REINFORCING STEEL

Position strands, ties, supports, reinforcing bars of the sizes shown on the plans and bearing plates in accordance with the detailed dimensions shown on the plans and effectively secure against displacement from their correct positions. For prestressing strands, do not allow deflections or displacements of any kind between the end anchorages unless shown on the plans. Place the steel reinforcing in final position after tensioning of the strands. Bend all tie wires to the inside of the member so that the ends are farther from the edge than the material tied. Support bottom strands spacings not to exceed 20 feet by supports meeting the requirements of Article 1070-4 or by other approved means. Plastic supports may be used when approved.

Strands with kinks, bends, nicks, scale, excessive rust, or other defects are not permitted. No more than one broken wire per casting bed is permitted. Slight rusting is not cause for rejection, provided it is not sufficient to cause visible pits. Take precautions to prevent contamination of strands and reinforcing steel. Clean the strands and reinforcing steel to an acceptable condition before pouring concrete. Do not place concrete in the forms until the strand and reinforcement condition and arrangement are inspected by the plant inspector.

Strand splices are only permitted at the end of a reel and when using a single strand jack. Ensure that the strand lengths to be spliced together have the same lay of wire to avoid unraveling and position the splice so that it does not fall within a member. Do not torch cut the ends of the spliced strand lengths. Cut by shears, abrasive grinders, or other means approved by the Engineer. No more than one strand splice is permitted on an individual strand and the reuse of strands is not permitted.

Where debonding of strands is required, accomplish by encasing the strand in a tubular conduit capable of resisting the pressure exerted by the concrete. Do not use slit conduit. Use a conduit of high density polyethylene or polypropylene with a minimum wall thickness of 0.025". Ensure that the inside diameter of the conduit is of sufficient size to allow free movement of the encased strand but not greater than the diameter of the strand plus 1/8". Secure the conduit so that longitudinal movement along the strand is prevented, and bonding of the strand is prevented at the required location plus or minus 1". Prevent concrete from

entering the conduit by taping. Use tape manufactured from a non-corrosive material compatible with the concrete, conduit, and steel.

1078-8 TENSIONING PROCEDURE

Tension each strand to the load shown on the plans prior to placing the concrete.

Measure the load induced in the prestressing strand both by jacking gages and strand elongations on at least the first 5 strands and every third strand thereafter on each pour. Measure loads on all other strands by either jacking gages or strand elongations. When both methods of measurement are used, if a discrepancy between gage and elongation of more than 5 percent is apparent, carefully check the entire operation and determine the source of error before proceeding. Make appropriate allowances in the computed elongation and jacking loads for load losses due to friction and all possible slippage or relaxation of the anchorage. Establish references periodically at each strand anchorage to indicate any yielding or slippage that may occur between the time of initial tensioning and final release of the strands.

In determining the applied load by measuring the elongation of the strand, use a modulus of elasticity taken from the typical stress-strain curve for the brand, size, and type of strand tensioned. Submit stress-strain curve data for the actual heats of material used in the strands to the plant inspector before using the strands. Identify each reel or strand by tagging in accordance with AASHTO M203. Mark the outer layer of each reel pack of strand with a wide color band as follows: white for 270K stress relieved strand, green for low relaxation strand, and a double marking of green and red for special low relaxation strand. In addition, attach a metal tag to each reel pack labeled in accordance with AASHTO M203.

Tension strands in a group or individually. Prior to full tensioning, bring each strand to an initial tension of 2,000 lbs. for all beds under 150 ft. in length, 3,000 lbs. for all beds 150 to 300 ft. in length, and 4,000 lbs. for all beds longer than 300 ft. in length. Measure this initial tension by a calibrated gauge or other approved means, and then compute the elongation due to initial tensioning. Use the difference between the required final tension and the initial tension to compute the expected additional elongation.

For precast prestressed deck panels, use a final prestressing force of 14,000 lbs. per strand for Grade 250 strand and 16,100 lbs. per strand for Grade 270 strand.

After initial tensioning, tension the strands until the required elongation and jacking load are attained and reconciled within the limits specified above. Keep a permanent record of the initial jacking load, the final jacking load, and the elongation produced thereby.

In single strand tensioning, rotation of the jacking ram is not allowed.

When draped strands are used, submit 6 sets of the bed layout showing the method of draping and tensioning the draped strands and also calculations determining the loads required for tensioning the draped strands. Drape the strands for all members to be cast in any one tensioning operation before casting any beam. Have end templates or bulkheads at ends of beams remain vertical or as otherwise shown on the plans. Perform draping for all members either simultaneously or in single or incremental lifts beginning at the center of the bed and working outward toward each end of the bed. Complete tensioning in the fully draped position is not allowed unless approved in writing.

Use round steel rollers of a type and dimensions approved by the Engineer for deflecting the draped strands. Round the part in contact with the strand to a diameter of not less than 3/4". Use support and hold-down devices of sufficient rigidity with adequate support so that the final position of the strands is as shown on the plans.

With strands tensioned in accordance with the above requirements and with other reinforcement in place, cast the concrete members so as to achieve the required lengths. Maintain strand load between anchorages until the concrete reaches the required compressive strength for transfer of load from the anchorages to the members.

For personnel engaged in the tensioning operation, provide protection by means of effective shields adequate to stop a flying strand. Provide shields produced from steel, reinforced concrete, heavy timbers, and other approved material at both ends of the bed.

1078-9 PLACING CONCRETE

Place concrete in accordance with Article 1077-8 and the additional requirements of this article.

Place concrete for girders 54" or less in height, and concrete for all cored slabs and box beams, in 2 or more equal horizontal layers. Place concrete for girders over 54" height in 3 horizontal layers. When placing concrete in 3 layers, locate the top of the first layer approximately at the top of the bottom flange and locate the top of the second layer approximately at the top of the web. Place and compact each layer before the preceding layer takes initial set so that there is no surface of separation between layers. Should shrinkage or settlement cracks occur, the Engineer reserves the right to require additional layers and/or vibration.

The requirement of the above paragraph may be waived with the permission of the Engineer if self consolidating concrete is used.

Internal or a combination of internal and external vibration is required as is necessary to produce uniformly dense concrete without honeycomb.

Place concrete in cold weather in accordance with the requirements of Article 420-9.

Place concrete in daylight unless an adequate lighting system meeting the approval of the Engineer is provided.

Do not exceed a temperature of 95°F in the freshly mixed concrete when placed in the forms.

Place the concrete in the bed in one continuous operation, finishing each member before proceeding to the next one. If the pour shall be stopped before the concrete in all the members in the bed is placed, start curing immediately. Do not place concrete in any remaining members in that bed setup once curing at elevated temperatures has begun.

Rough float the tops of girders. Give the top surface of cored slabs a broom finish. Finish prestressed concrete members that are intended for composite action with subsequently placed concrete with a roughened surface for bonding. Make sure that no laitance remains on the surfaces to be bonded.

When box beams are cast, employ a positive hold-down system to prevent the voids from moving. Design the system to be left in place until the concrete has reached release strength. At least six weeks prior to casting box beams submit to the Engineer for review and comments, detailed drawings of the proposed void material and hold-down system. In addition to structural details, indicate the location and spacing of the holds-downs. Submit the proposed method of concrete placement and of consolidating the concrete under the void.

1078-10 CURING CONCRETE

(A) General

Cure concrete by steam curing, radiant heat curing or water curing, as set forth below. As an option, cure concrete for prestressed piles with membrane curing compound as set forth below. Use a method or methods that prevent the concrete from losing moisture at any time before curing is complete. Use methods that do not deface or injure the concrete. Use curing procedures that prevent cracks from occurring in the members. Cure all members in any one bed by the same method.

Continue the curing period until the concrete reaches sufficient strength to permit transfer of load from the anchorage to the members. As soon as the concrete attains release strength, immediately release all forms in a continuous operation, without delay for other activities such as the cleaning of forms. Immediately following the removal of the forms, de-tension the members.

(B) Curing at Elevated Temperatures

Perform radiant heat curing under a suitable enclosure that contains the heat and prevent moisture loss. Apply moisture by a cover of moist burlap, cotton matting, or similar approved material. Retain moisture by covering the member with an approved waterproof sheeting in combination with an insulating cover. Support the cover at a sufficient distance above the member being cured to allow circulation of the heat.

Provide steam curing enclosures essentially free of steam leakage in order to minimize moisture and heat losses. Do not allow the enclosure to come in contact with the members or forms for the members. Do not direct steam jets on the forms so as to cause localized high temperatures.

After placing and vibrating, allow the concrete to attain its initial set prior to the application of heat or steam. The concrete is considered to obtain its initial set when it has a penetration resistance of at least 500 psi when tested in accordance with AASHTO T197. Take the sample of concrete tested for penetration resistance from the last load cast in the bed. Store the sample of concrete with the precast member and maintain in the same condition and environment as the member except for the periods of time necessary to prepare the test specimen and to perform the penetration resistance test. Conduct the penetration resistance test.

As an option, submit data indicating that an approved concrete mix attains its initial set after some particular time period. Different periods may be required for different weather conditions. If such data is submitted, consideration is given to permitting heat or steam introduced after the time indicated by such data in lieu of having to

perform the penetration resistance test. Consideration is also given to determining the time of initial set by methods other than AASHTO T197 provided data supporting such other methods is submitted.

When the ambient air temperature is below 50°F, cover the forms after the placement of concrete and apply sufficient heat to maintain the temperature of the air surrounding the unit between 50° and 70°F.

When the ambient air temperature is above 70°F, initiate a water cure as set forth below or other approved method as soon as the concrete is able to receive the water without physical damage to its surface. Discontinuation of the cure is allowed upon introduction of steam, provided that a relative humidity of 100 percent is maintained.

Cure at elevated temperatures at a temperature of not more than 160°F.

Maintain a relatively uniform rate of increase of the temperature within the curing enclosure of approximately 40°F per hour, not to exceed 15°F per 15 minutes. Ensure that the temperature increase is relatively uniform throughout the length and on both sides and top of the concrete unit. Place recording thermometers within 50 feet of each end of the bed and at points not to exceed 100 feet between the end thermometers. Provide a minimum of 2 thermometers for bed lengths of 100 feet or less. Calibrate recording thermometers at intervals not to exceed 6 months. Ensure that the temperature differential within the curing enclosure does not exceed 15°F. Submit complete temperature records for all cures before final approval of the members.

Continue steam curing until the concrete reaches the required transfer strength.

(C) Water Curing

Keep the concrete continuously wet by the application of water as soon as possible without damage to the concrete surface, and before the concrete obtains an initial set of 500 psi. Apply the water using soaker hoses and wet burlap or other approved means for the full length of each member. Apply water evenly along the entire length of the bed.

When the ambient air temperature is below 50°F cover the forms after the placement of the concrete and apply sufficient heat in an approved manner to maintain the temperature of the air surrounding the member between 50°F and 70°F. After the concrete obtains an initial set of 500 psi, the air temperature surrounding the member is allowed to increase to 100°F while continually maintaining moisture on the surface of the concrete. Whenever heat is applied to the member, place temperature recording clocks on the bed as required when curing at elevated temperatures. The requirements for rate of temperature increase also apply.

Maintain the application of heat (if used) and water until the concrete obtains release strength.

(D) Curing with Membrane Curing Compound

As an option, cure prestressed concrete piles with a membrane curing compound. Spray the entire surface of the concrete uniformly with a wax-free, resin-base curing

compound conforming to the requirements of Article 1026-2. Use clear curing compound to which a fugitive dye is added for color contrast.

Apply the membrane curing compound after the surface finishing is complete, and immediately after the free surface moisture disappears. In the event the application of curing compound is delayed, start another curing method immediately and continue until the application of the curing compound is started or resumed or until the concrete reaches the required detensioning strength.

Seal the surface with a single uniform coating of the specified type of curing compound applied at the rate of coverage recommended by the manufacturer or as directed by the Engineer, but not less than 1 gallon per 150 square feet of area.

At the time of use, thoroughly mix the compound in a condition with the pigment uniformly dispersed throughout the vehicle. If the application of the compound does not result in satisfactory coverage, stop the method and apply water curing, as set out above, until the cause of the defective work is corrected.

At locations where the coating shows discontinuities, pinholes, or other defects, or if rain falls on the newly coated surface before the film dries sufficiently to resist damage, apply an additional coat of the compound immediately after the rain stops at the same rate specified herein.

When the ambient air temperature is below 50°F, cover the forms after the application of the curing compound and apply sufficient heat in an approved manner to maintain the temperature of the air surrounding the member between 50°F and 70°F. Whenever heat is applied to the members, place recording thermometers on the bed as required when curing at elevated temperatures. The requirements for rate of temperature increase also apply.

Completely remove any curing compound adhering to a surface to which new concrete is bonded by sandblasting, steel wire brushes, bush hammers, or other approved means.

Protect the concrete surfaces to which the compound is applied from abrasion or other damage that results in perforation of the membrane film until the concrete achieves design strength and the members are de-tensioned.

1078-11 TRANSFER OF LOAD

Transfer load from the anchorages to the members when the concrete reaches the required compressive strength shown on the plans. Remove or loosen all formwork and release any hold-downs in one continuous operation as quickly as possible as soon as release strength is obtained. As soon as the forms are removed, transfer the load from the anchorages to the members as quickly as possible in one continuous operation using the approved detensioning sequence.

For any particular group of members cast in the same bed, do not transfer the load to any concrete until the test cylinder breaks indicate that the concrete in all these members has reached the required strength as outlined in Subarticle 1078-4(B)(3). If these conditions are not met, delay the transfer of the prestressing load to the concrete until tests of additional cylinders show that the required strength is reached.

When curing at elevated temperatures, begin the procedures for transferring prestressing load immediately after curing is discontinued and the forms are released, and while the concrete is still hot in order to prevent cooling shrinkage and cracking. If so directed by the Engineer, cover members or otherwise protect so as to cool the concrete slowly after release in order to prevent thermal shock and the evaporation of moisture in the members.

Transfer load to not cause cracks in members. Transfer load by gradual release of the strands as a group, by gradual release of part of the group, or by burning the fully tensioned strands at the ends of the members. If intending to release the strands by a method other than gradual release of the entire group, submit 6 copies of the proposed method and pattern of release, if not so shown on the plans, for approval. Rigidly follow the approved method and pattern of release. When the fully tensioned strands are burned, burn each strand or group of strands simultaneously at each end of the bed in its indicated order in the pattern and at each end of each member before proceeding to the strands in the next group in the pattern at any point. Because of the critical nature of the bond development length in prestressed concrete panel construction, if transferring of stress by burning the fully tensioned strands at the ends of the member, burn each strand first at the ends of the bed and then at each end of each member before proceeding to the next strand in the burning pattern.

When detensioning all girders, box beams, cored slabs, piles, and panels do not burn strands quickly but heat with a low oxygen flame played along the strand for a minimum of 5" until the metal gradually loses its strength. Apply heat at such a rate that failure of the first wire in each strand does not occur until at least 5 seconds after heat is first applied. When detensioning other members, follow the above procedure unless an alternate procedure is approved. Detensioning by arc welder is not allowed.

Incorporate the following in the method for single strand detensioning of members having draped strands:

(A) Release the pair of straight strands located in the uppermost position in the lower flange first.

(B) Then release the tension in the draped strands at the ends and uplift points in accordance with an approved pattern.

(C) Disengage all hold-down devices for draped strands and release the hold-downs.

(D) Then release the pair of straight strands located in the upper flange.

(E) Release the remaining straight strands of the pattern in accordance with an approved sequence.

(F) Release all strands in a manner meeting the Engineer's approval that will cause a minimum shock and lateral eccentricity of loading.

Failure to follow the above procedures for transfer of load is ground for rejection of the members involved.

1078-12 VERTICAL CRACKS IN PRESTRESSED CONCRETE GIRDERS PRIOR TO DETENSIONING

Provide prestressed concrete girders without objectionable cracks. This Specification addresses prestressed concrete girders that have vertical casting cracks in the middle half of

the member length prior to strand detensioning. Certain types of these cracks have been determined by the Department to render the girders unacceptable.

Unacceptable cracked members include, but are not limited to, those with two or more full height vertical cracks spaced at a distance less than the member depth. Such members are not considered serviceable and will be rejected. Full height cracks are cracks that begin at or near the top of the member and extend down to or below the center of gravity of the bottom group of prestressed strands.

Except as noted above, members with one or more vertical cracks that extend into the bottom flange are subject to an engineering assessment to determine their acceptability. If this engineering assessment is required, submit, at no additional cost to the Department, a proposal for repairing the member and a structural evaluation of the member prepared by a North Carolina Licensed Professional Engineer. In the structural evaluation, consider the stresses under full service loads had the member not cracked and the effects of localized loss of prestress at the crack as determined by methods acceptable to the Department.

For members designed for zero tension under full service loads, the maximum magnitude of the computed concrete tension at the lower end of the cracks is the square root of the specified design strength of the concrete. The maximum width of the crack at the bottom of the web is 3 mils after detensioning. For all other members, the maximum magnitude of the computed concrete tension at the lower end of the crack is 350% of the square root of the specified design strength of the concrete, and the maximum width of the crack at the bottom of the web is 4 mils after detensioning.

The Department has final determination regarding acceptability of any members in question.

1078-13 PRESTRESSED CONCRETE GIRDER WEB SPLITTING

After detensioning of certain girders with draped strands, cracks occasionally occur in the webs at the ends of the girders. If such cracks occur, employ a method to remedy this condition on all subsequent girders of the same type and strand pattern. If debonding of strands is used, satisfy the following criteria:

(A) Debond alternate rows of draped strands 2 feet from each end of the girder.

(B) Do not debond the two straight strands in the top of the girder. Debond one half of the straight strands, as nearly as possible, in the bottom flange. As nearly as possible, debond one quarter of the straight strands in bottom of girder 4 feet from each end of the girder and debond one quarter of the straight strands 2 feet from each end of the girder.

(C) Use a debonding pattern that is symmetrical about the vertical axis of the girder for both draped and straight strands.

(D) Debond strands so that the centers of gravity of the draped strands and the straight strands in the bottom of the girder remain within 1" of their original location at the end of the girder.

(E) Debond strands by encasing the strand in a conduit meeting the approval of the Engineer. Conduit may be rigid one-piece or rigid two-piece split sheathing. Do not use flexible conduit or sheathing.

No separate payment is made for debonding strands as payment is included in the contract unit price bid for prestressed concrete girders.

1078-14 HANDLING, TRANSPORTING AND STORING

Members damaged while being handled or transported are rejected or require repair in a manner approved by the Engineer. All members are allowed to be handled immediately after transfer of load from the anchorages to the members is complete.

Store all prestressed members on solid, unyielding, storage blocks in a manner to prevent torsion or objectionable bending. In handling prestressed concrete girders 54" or less in height, including cored slabs, maintain them in an upright position at all times and pick them up within 3 feet of the points of bearing and transport and store supported only within 3 feet of points of bearing. In handling prestressed concrete girders greater than 54" in height, maintain them in an upright position at all times and submit for approval the proposed method of lifting, transporting, and storing the girders.

Prestressed concrete panels are weak in the direction perpendicular to the prestressing strands, therefore, they are subject to breakage during handling, storing or transporting. Provide adequate blocking during all of these construction phases.

In handling, transporting, and storing prestressed members, utilize the number and location of supports in accordance with the plan requirements for the sizes, lengths, and types of members involved, or as approved.

When handling the prestressed concrete members, a temporary stress of $5\sqrt{f_{ci}}$ is permitted, where f_{ci} is the strength of concrete at release, in psi.

Do not transport members away from the casting yard until the concrete reaches the minimum required 28 day compressive strength and a period of at least 5 days elapses since casting, unless otherwise permitted.

Do not transfer any member from the plant to the job site prior to approval of that member by the plant inspector. This approval is stamped on the member by the plant inspector.

1078-15 FINAL FINISH

Broom finish the top surface of the cored slab sections. No surface finish is required for sides and bottom of the slab sections except the exposed side of the exterior slab sections as noted below. Provide a resulting surface finish essentially the same color and surface finish as the surrounding concrete.

Rake the top surface of the box beam section to a depth of 3/8". No surface finish is required for sides and bottom of the box beam sections except the exposed side of the exterior beam section as noted below. Provide a resulting surface finish essentially the same color and surface finish as the surrounding concrete. Fill all voids in the outside face of exterior box beams with a sand-cement or other approved grout. Repair voids greater than

1/4" in diameter or depth in other faces of the box beams in a like manner. Where an excessive number of smaller voids exist in any member, the Engineer requires a similar repair.

Provide a 3/4 " chamfer along the bottom edges on ends and sides of all box beam and slab sections, top outside edges of exterior sections and acute corners of sections. Round the top edges on ends of all sections with a 1/4" finishing tool. Provide square corners along top edges on all sections along shear keys. Do not chamfer vertical edges at ends of sections.

Fill all voids in the diagonal face of the bottom flange of prestressed concrete girders and the outside face of exterior cored slabs with a sand-cement or other approved grout. Fill all voids in piles greater than 1/2" in diameter or depth as above. Provide a resulting surface finish essentially the same color and surface finish as the surrounding concrete. Repair voids greater than 1/4" in diameter or depth in other faces of these and other members except piles in a like manner. Where an excessive number of smaller voids exist in any member, the Engineer requires a similar repair.

Repair honeycomb, excessively large fins, and other projections as directed. Do not repair members with honeycomb, cracks, or spalls until inspected by the Engineer. Any appreciable impairment of structural adequacy that cannot be repaired to the satisfaction of the Engineer is cause for rejection.

Clean and fill holes caused by strand hold downs upon removal from the casting bed. Use patches of materials approved by the Engineer that develop strength at least equal to the minimum 28 day strength requirement for the concrete prior to approval of the member. Ensure that members are clean and surfaces have a uniform appearance.

Give the top surface of prestressed concrete panels a raked finish or other approved finish to provide an adequate bond with the cast-in-place concrete. As soon as the condition of the concrete permits, rake the top surface of the concrete making depressions of approximately 1/4". Take care when raking not to catch and pull the coarse aggregate.

Clean reinforcing bars exposed on the tops of girders and exterior cored slabs of mortar build up and excessive rust.

Apply epoxy protective coating to the ends of prestressed members as noted on the plans.

1078-16 ALIGNMENT AND DIMENSIONAL TOLERANCES

(A) Cored Slabs

In order to ensure a good, neat field fit, assemble cored slab spans in the yard and have pieces matchmarked. Ensure that pieces fit together neatly and in a workmanlike manner.

Manufacture cored slabs within the tolerances indicated in Table 1078-3.

TABLE 1078-3
TOLERANCES FOR PRESTRESSED CORED SLABS

Dimension	Tolerance
Depth (A)	+3/8" to -1/8"
Width (B)	±1/4"
Length (C)	±1/8" per 10'
Position of voids - Vertical (D)	±3/8"
Position of voids - Horizontal (E)	±3/8"
Position of void Ends – Longitudinal	+1", -3"
Square ends - Deviation from square (horizontal)or vertical) or designated skew (F)	±1/4"
Horizontal alignment - Deviation from a straight line parallel to the centerline of member (G)	0-30 ft. long: 1/4" 30-50 ft. long: 3/8" 50+ ft. long: 1/2"
Camber - Differential between adjacent units (H)	1/4" per 10', 3/4" max.
Camber - Differential between high and low members of same span (H)	3/4" max.
Position of dowel holes - Deviation from plan position (I)	1/4"
Width - Any one span	Plan width +1/8" per joint
Width - Differential of adjacent spans in the same structure	3/4"
Bearing area - Deviation from plane surface	1/16"
Local smoothness (J)	1/4" in 10'
Position of holes for transverse strands	Horizontal (K): ±1/2" Vertical (L): ±3/8"
Position of strands (M)	±1/4"

NOTE: Dimensions followed by an alphabetical suffix are shown in Figure 1078-1

(B) Girders

Manufacture girders within the tolerances indicated in Table 1078-4.

(C) Piles

Manufacture piles within the tolerances indicated in Table 1078-5.

(D) Sheet Piles

Manufacture sheet piles within tolerances indicated in Table 1078-6.

(E) Prestressed Concrete Panels

Manufacture prestressed concrete panels within the tolerances indicated in Table 1078-7.

(F) Box Beams

In order to ensure a good, neat field fit, assemble box beam spans in the yard and have pieces match-marked. Ensure that pieces fit together neatly and in a competent manner.

Manufacture box beams within the tolerances indicated in Table 1078-8.

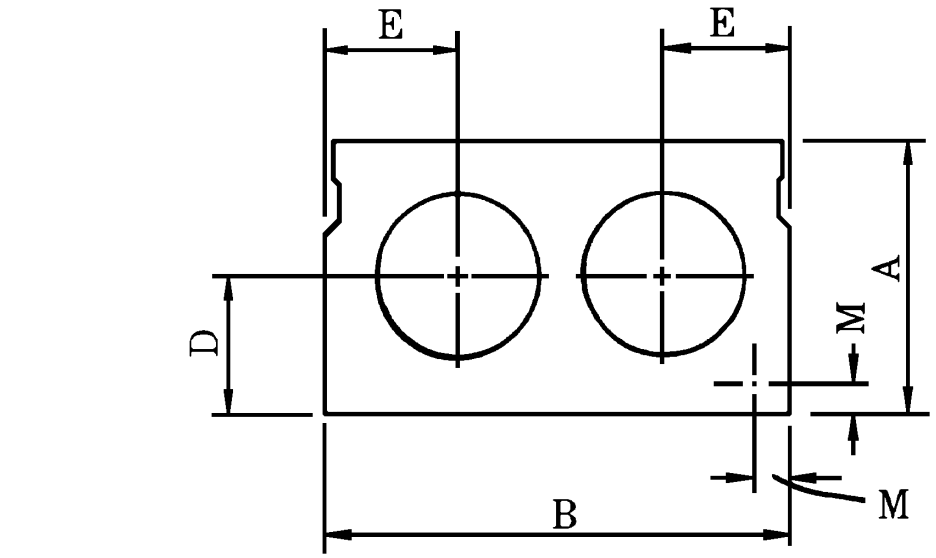
1078-16 IDENTIFICATION OF MEMBERS

Permanently identify each prestressed member by number and date of manufacture, and paint this information, or otherwise mark as approved by the Engineer, on at least one end of the member as soon as practical after manufacture. In the case of girders or cored slabs, also paint other identification as to station, span, and position within the span on at least one end of the member.

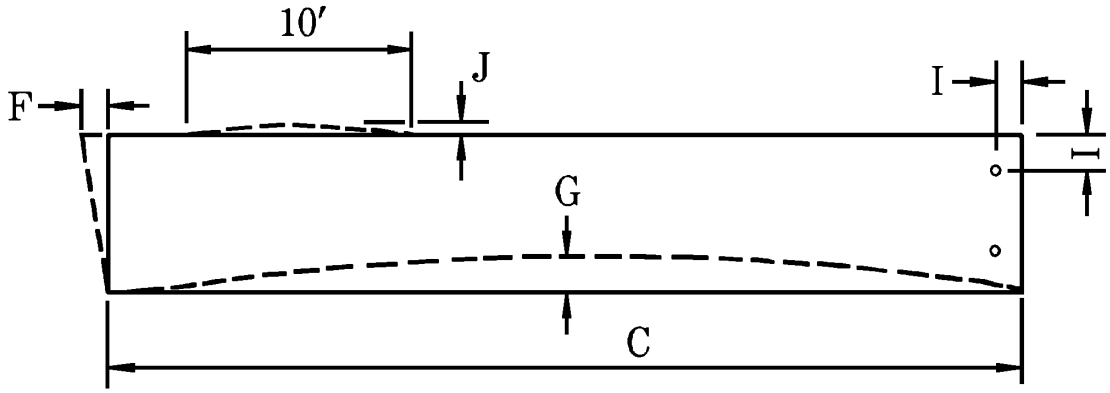
1078-17 QUALITY CONTROL

Maintain a daily quality control record form approved by the Engineer including pertinent information concerning tensioning, concrete quality and placement, curing, and detensioning. Have this form signed and dated by a certified concrete technician. Furnish a copy of the completed or up-to-date form to the Materials and Tests Unit upon request and before any members are approved. A sample form, indicating the minimum required information, is available from the Materials and Tests Unit.

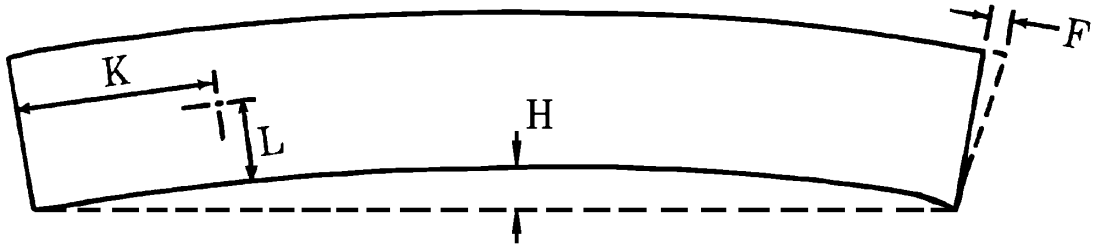
FIGURE 1078-1
PRESTRESSED CORED
SLABS



SECTION



PLAN



ELEVATION

TABLE 1078-4
TOLERANCES FOR PRESTRESSED GIRDERS

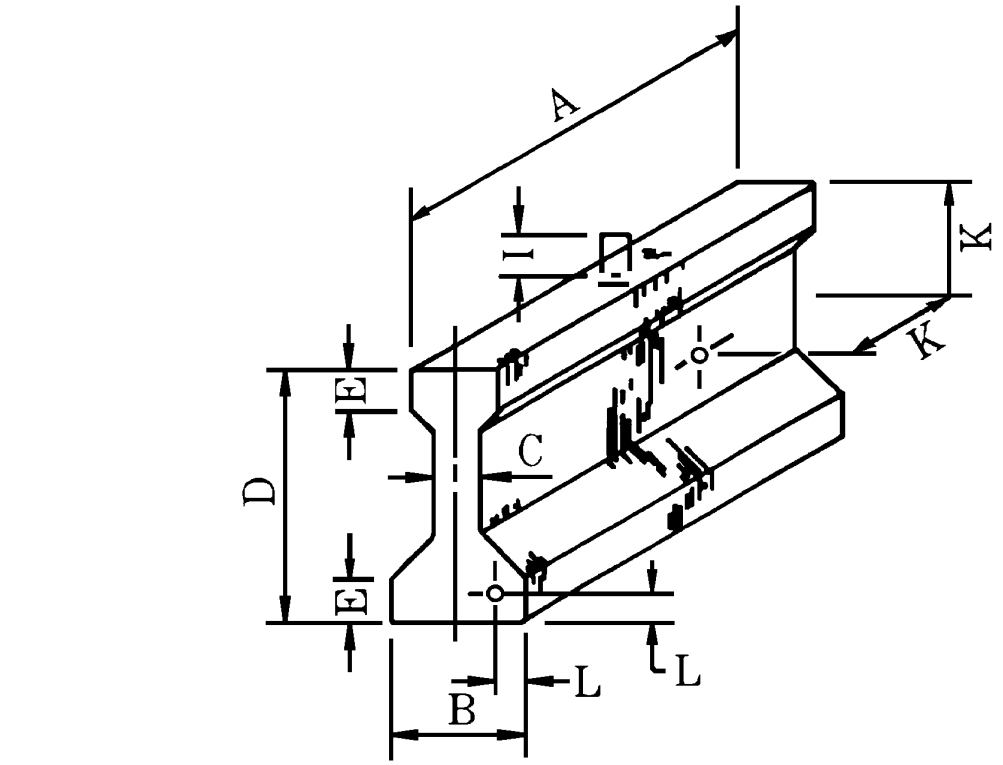
Dimension	Tolerance
Length (A) Girders 80 ft. or shorter	±1/8" per 10'
Length (A) Girders longer than 80 ft.	±1/8" per 10' Not to exceed 1 1/2"
Width - Flanges(B)	+3/8" to -1/8"
Width - Web (C)	+3/8" to -1/8"
Depth - Overall (D)	+1/2" to -1/4"
Depth - Flanges (E)	±1/4"
Horizontal alignment (top or bottom flange) - Deviation from a straight line parallel to the centerline of beam (F)	 1/8" per 10' Not to exceed 1"
Bearing plate – Deviation from plane surface	1/16"
Girder ends – Deviation from square or Designated skew (G and H)	Vertical (G): ±1/8" per 12" of girder height. Horizontal (H): ±1/2"
Position of stirrups - Projection Above top of girder (I)	 ±1/2"
Position of stirrups – Placement along girder length	±1"
Local smoothness of any surface (J)	1/4" in 10'
Position of holes for tie rods (K)	±1"
Position of strands (L)	±1/4"

NOTES: Dimensions followed by an alphabetical suffix are shown in Figure 1078-2

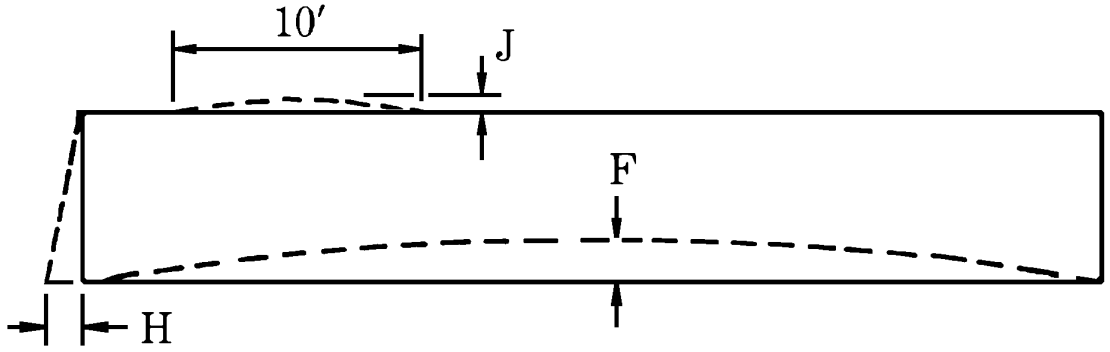
The length (A) is measured along the top of the top flange.

The tolerances at girder ends (G & H) are increased to 1" if the girder end is to be encased in a full depth concrete diaphragm

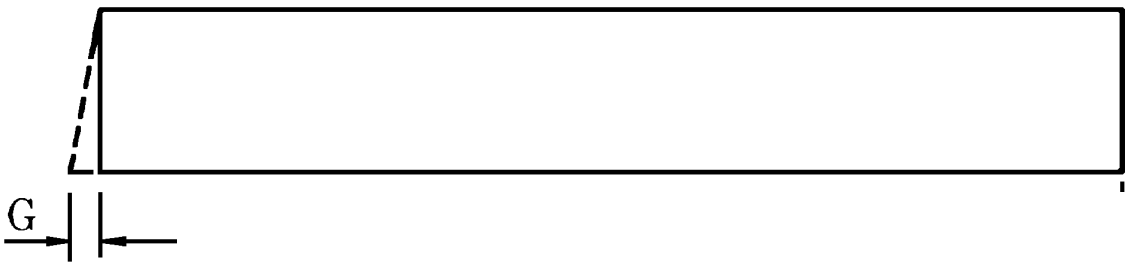
FIGURE 1078-2
PRESTRESSED GIRDERS



ISOMETRIC



PLAN



ELEVATION

TABLE 1078-5
TOLERANCES FOR PRESTRESSED PILES

Dimension	Tolerance
Width (A)	-1/4" to +3/8"
Length (B)	±1 1/2"
Horizontal alignment - Deviation from a straight line parallel to the centerline of pile (C)	1/8" per 10'
Squareness of ends (D)	1/8" per 12" of width, 3/16" max.
Local smoothness (E)	1/4" in 10'
Position of strands (F)	1/4"
Position of mild reinforcing steel, including spiral pitch	1/2"

NOTE: Dimensions followed by an alphabetical suffix are shown in Figure 1078-3

FIGURE 1078-3
PRESTRESSED PILES

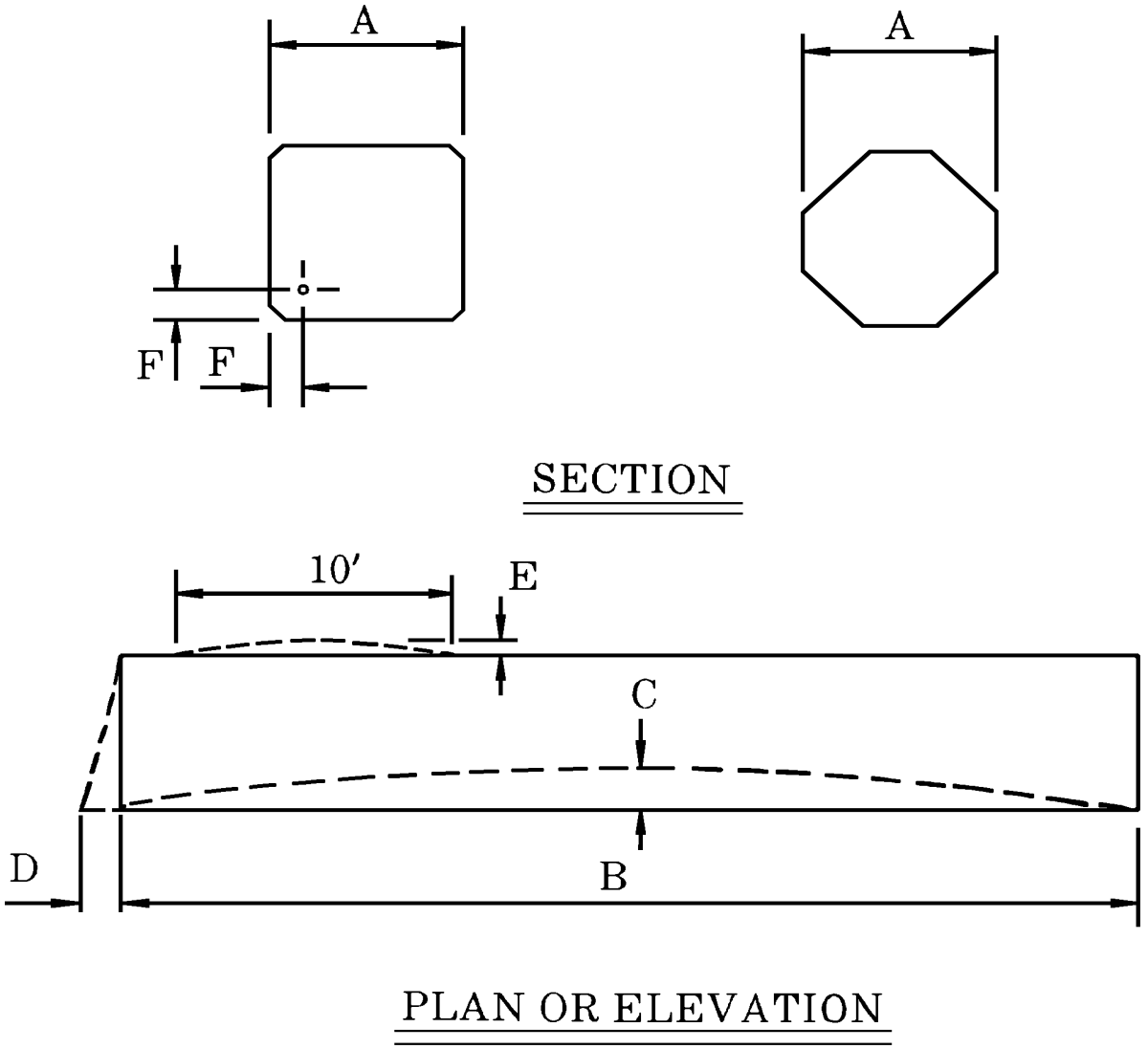


FIGURE 1078-4
PRESTRESSED SHEET PILES

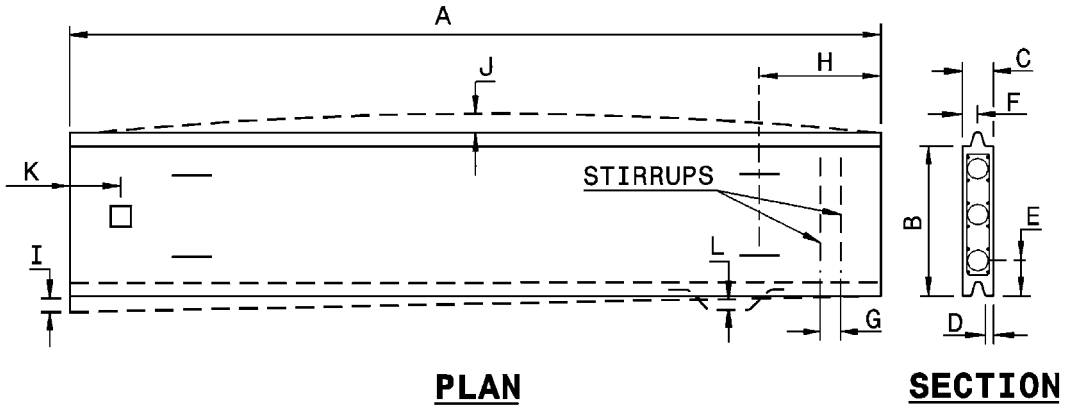


TABLE 1078-6
TOLERANCES FOR PRESTRESSED SHEET PILES

Dimension	Tolerance
Length(A)	±1"
Width(B)	±3/8"
Depth (C)	±1/4"
Position of Tendons (D)	±1/4"
Position of Voids (E)	
Longitudinal	±1/2"
Transverse	±1/2"
Vertical	±1/4"
Wall Thickness (F)	±1/2"
Longitudinal Spacing of Stirrups (G)	±3/4"
Position of Handling Devices (H)	
Longitudinal	± 6"
Transverse	±1/2"
Vertical	±1/2"
Variation from Specified End Squareness or Skew (I)	1/4" per 10' ±1/2" max.
Sweep (J)	±1/8" per 10'
Position of Blockouts (K)	±1"
Local Smoothness (L)	±1/4" per 10'

TABLE 1078-7
TOLERANCES FOR PRESTRESSED CONCRETE PANELS

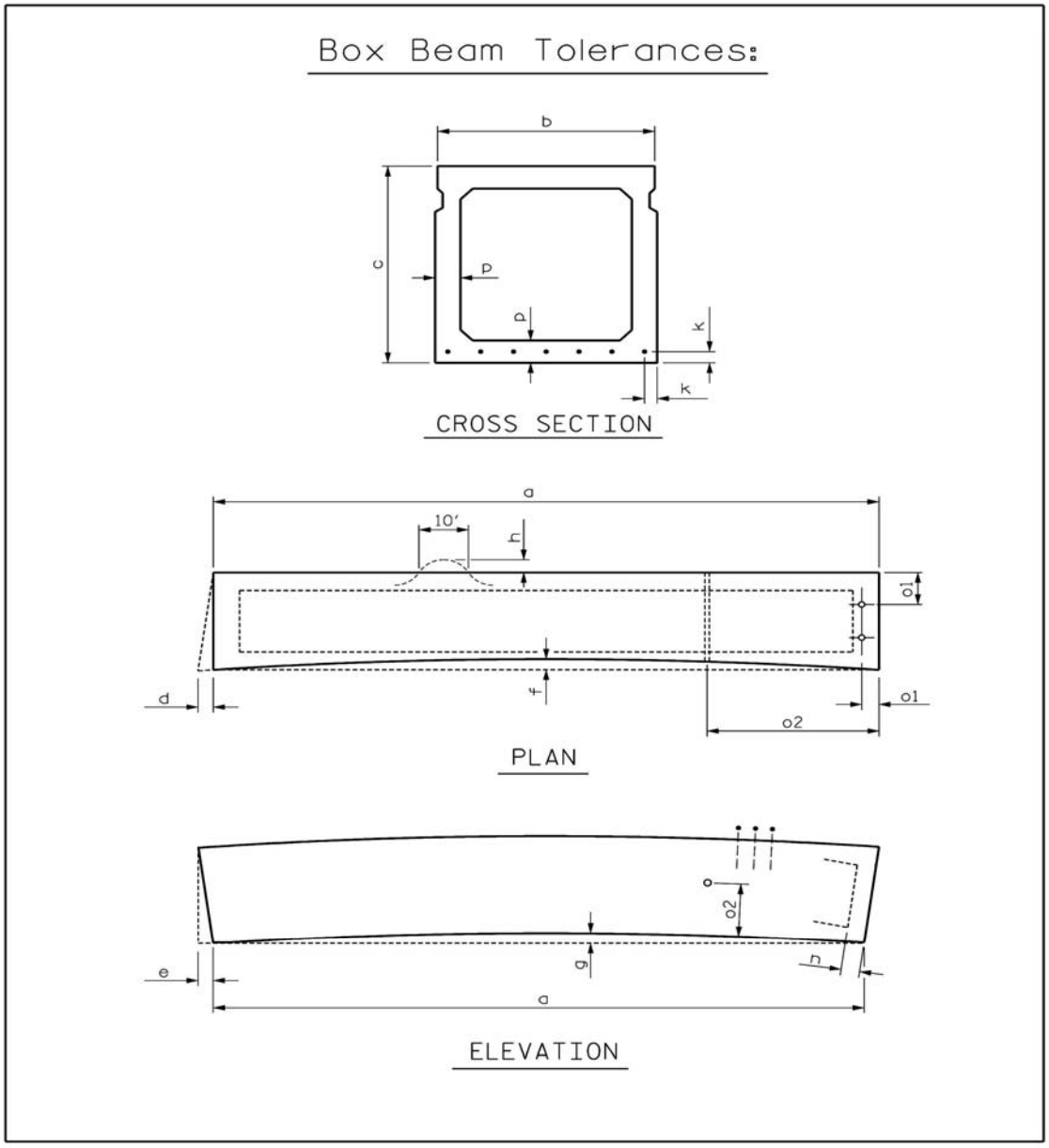
Dimension		Tolerance
Length (Transverse direction to girders)		-1/4" to +1/2"
Width (Longitudinal direction to girders)		-1/8" to +1/4"
Depth		0 to +3/8"
Position of Strand	Vertical Dimension Horizontal Dimension	± 1/8" ± 1/2"

TABLE 1078-8
TOLERANCES FOR BOX BEAMS

Length (A)	± 1"
Width (overall) (B)	± 1/4"
Depth (overall) (C)	± 1/4"
Variation from specified plan end squareness or skew (D)	± 1/8" per 12" width, ± 1/2" max
Variation from specified elevation end squareness or skew (E)	± 1/8" per 12", ± 1/2" max
Sweep, for member length (F):	
up to 40 ft	± 1/4"
40 to 60 ft	± 3/8"
greater than 60 ft	± 1/2"
Differential camber between adjacent members (G):	1/4" per 10 ft., 3/4" max
Local smoothness of any surface (H)	1/4" in 10 ft
Position of strands (K)	± 1/4"
Longitudinal Position of blockout (N)	± 1"
Position of dowel holes (o1)	± 1/4”
Position of sleeves cast in beams, in both horizontal and vertical plane (o2)	± 1/2"
Position of void (P)	± 3/8”
Bearing area – deviation from plane surface	± 1/16”
Width of any one span	Plan width + 1/8” per joint

NOTE: Dimensions followed by an alphabetical suffix are shown in Figure 1078-5

FIGURE 1078-5
PRESTRESSED BOX BEAMS



SECTION 1079
BEARINGS AND BEARING MATERIALS

1079-1 PREFORMED BEARING PADS

Provide preformed bearing pads composed of multiple layers of 8 ounce per square yard cotton duck impregnated and bound with high quality natural rubber, or equally suitable materials approved by the Engineer, that are compressed into pads of uniform thickness. Ensure that the thickness of the preformed bearing pads is 3/16" with a tolerance of plus or minus 1/16". Use cotton duck that meets the requirements of Military Specification MIL-C882-D for 8 oz./sy cotton army duck or equivalent. Provide enough pads as to produce the

required thickness after compressing and vulcanizing. Ensure that the finished pads withstand compressive loads perpendicular to the plane of the laminations of not less than 10,000 psi without detrimental extrusion or reduction in thickness.

Furnish a Type 3 certification in accordance with Article 106-3 certifying that the preformed bearing pads meet the requirements of this Specification.

1079-2 ELASTOMERIC BEARINGS

(A) General

Elastomeric bearings are either plain (consisting of elastomer only) or laminated (consisting of alternating individual layers of elastomer and non-elastic laminates) as shown on the plans. Preformed bearing pads are not required with elastomeric bearings.

Provide elastomer for bearings formulated from previously unvulcanized 100% virgin polychloroprene (neoprene) or 100% virgin natural polyisoprene (natural rubber). Mold all plain bearings individually, or cut from previously molded strips or slabs molded to the full thickness of the finished bearings, or extrude and cut to length. Ensure that the finished bearings have no voids or separations. Supply plain elastomeric bearings that are well-vulcanized, uniform, integral units of such construction that the bearing is incapable of separation by any mechanical means into separate, definite, well-defined elastomeric layers. Evidence of such layered construction either at the outer surfaces of the bearing or within the bearing is cause for rejection of such bearing shipments.

Mold all components of a laminated bearing together to form an integral unit free of voids or separations in the elastomer or between the elastomer and the non-elastic laminates. Ensure that the elastomer between the laminates is well vulcanized, uniform and integral such that it is incapable of separation by any mechanical means into separate, definite, well-defined elastomeric layers. Evidence of such layered construction, either at the outer surfaces or within the bearing, is cause for rejection of such laminated bearing shipments. Provide non-elastic steel laminates conforming to AASHTO M270 Grade 36, ASTM A570, or an approved steel equivalent. Provide outer metal laminations that are 3/16" and inner laminations that are 14 gage or 12 gage as indicated on the plans. Provide outer laminations of elastomer that are 1/4" minimum and inner laminations that are all of equal thickness as shown on the plans. Ensure a minimum cover of 1/8" of elastomer over edges of all metal laminations. Include top and bottom bearing surfaces that have an integral sealing rib a minimum of 1/8" in depth (in addition to specified total thickness) and 3/16" in width around their peripheries.

Finish cut surfaces to at least as smooth as ANSI #250 finish. Mark the batch or lot number on each bearing in such a manner as to remain legible until the acceptability of the bearing is determined by Engineer. Place a piece-mark on each bearing in such a manner as to remain legible until placement in the structure.

(B) Elastomer Properties

Use elastomer formulated from neoprene meeting the requirements shown in Table 1079-1. Use elastomer formulated from natural rubber meeting the requirements shown in Table 1079-2. Provide test specimens that are in accordance with ASTM D15, Part B.

Provide Grade 50 durometer hardness elastomer in all bearings, unless otherwise noted on the plans.

TABLE 1079-1
NEOPRENE ELASTOMER REQUIREMENTS

Grade (durometer)	50	60
PHYSICAL PROPERTIES Hardness ASTM D2240 Tensile strength, minimum psi ASTM D412 Elongation at Break, minimum percent	 50+5 -5 2500 400	 60+5 -5 2500 350
ACCELERATED TEST TO DETERMINE LONG-TERM AGING CHARACTERISTICS OVEN AGED - 70 HRS, AT 212°F ASTM D573 Hardness, points change maximum Tensile strength, % change maximum Elongation at break, % change maximum	 0 to +15 –15 –40	 0 to +15 –15 –40
OZONE: 100 PPHM in air by volume 20% strain at 100 ± 2°F ASTM D1149*100 Hours	No Cracks	No Cracks
COMPRESSION SET 22 Hrs. at 212°F ASTM D395 (Method B) % Maximum	35	35
ADHESION ASTM D429, B Bond made during vulcanization, lbs./in	40	40
LOW TEMPERATURE RESISTANCE ASTM D746, Procedure B Brittleness at -40°F	No Failure	No Failure

* Wipe samples with solvent before test to remove traces of surface impurities.

TABLE 1079-2
NATURAL RUBBER ELASTOMER REQUIREMENTS

Grade (durometer)	50	60
PHYSICAL PROPERTIES Hardness ASTM D2240 Tensile strength, minimum psi ASTM D412 Elongation at Break, minimum percent	50+5 -5 2500 450	60+5 -5 2500 400
ACCELERATED TEST TO DETERMINE LONG-TERM AGING CHARACTERISTICS OVEN AGED - 70 HRS, AT 158°F ASTM D573 Hardness, points change maximum Tensile strength, % change maximum Elongation at break, % change maximum	 0 to +10 -25 -25	 0 to +10 –25 –25
OZONE: 25 PPHM in air by volume 20% strain at 100 ± 2°F. ASTM D1149* 48 Hours	No Cracks	No Cracks
COMPRESSION SET 22 Hrs. at 158°F ASTM D395 (Method B) % Maximum	25	25
ADHESION ASTM D429, B Bond made during vulcanization, lbs./in	40	40
LOW TEMPERATURE RESISTANCE ASTM D746, Procedure B Brittleness at -40°F	No Failure	No Failure
* Wipe samples with solvent before test to remove traces of surface impurities.		

Meet the following criteria under laboratory testing conditions of full size bearings:

Have the manufacturer proof load each laminated bearing to 150% of the maximum design dead load plus live load shown on the plans. If bulging patterns imply laminate placement that does not satisfy design criteria, or if bulging suggests poor

laminate bond, the bearing is rejected. If there are three separate surface cracks that are greater than 0.08" wide and 0.08" deep, the bearing is rejected.

Do not provide a bearing with a shear resistance, at 25% strain of the total effective rubber thickness and after an extended four-day ambient temperature of -20°F, exceeding 50 psi for 50 durometer or 75 psi for 60 durometer Table A compounds, or 30 psi for 50 durometer or 40 psi for 60 durometer for Table B compounds.

(C) Dimensional Tolerances

Provide material with a flash tolerance, finish and appearance meeting the requirements of the *Rubber Handbook, Second Edition* as published by the Rubber Manufacturers Association, Inc.: RMA-F3-T.063 for molded bearings and RMA-F2 for extruded bearings.

Permissible variation from the dimensions and configuration required by the contract is indicated in Table 1079-3.

TABLE 1079-3
Elastomer Bearing Tolerances

Overall vertical dimensions	- 0, +1/16"
Overall horizontal dimensions	- 0, +1/4"
Thickness of individual layers of elastomer (Laminated bearings only)	± 1/16"
Variations from a plane parallel to the theoretical surface	Top 1/8"
	Sides 1/4"
Edge cover of embedded laminates	- 0, +1/8"
Size of holes or slots	- 0, +1/8"
Position of holes or slots	- 0, +1/8"
Thickness of non-elastic laminates:	- 0, +1/16"

(D) Testing

Furnish all bearings that are produced by a bearing manufacturer who previously submitted the required pre-qualification test samples and certifications and whose elastomer formulation is initially approved for use by the Engineer. Obtain approval from the Engineer for each elastomer formulation produced by a manufacturer prior to its first use on Department projects. To pre-qualify and obtain initial approval of a particular formulation, have the bearing manufacturer submit to the Engineer, well in advance of anticipated use of the product, certified test results showing actual test values obtained when the physical properties of the elastomer are tested for compliance with the pertinent Specifications.

In addition, have the manufacturer forward pre-qualification test samples to the Engineer for testing and evaluation of compliance with pre-qualification requirements. Include in the pre-qualification samples at least two finished bearings typical of the formulation and workmanship intended for use on Department projects.

Have the bearing manufacturer certify that all of the samples submitted are of the same basic elastomer formulation and of equivalent cure to that used in the finished products furnished on Department projects.

If required, have the producer perform the complete pre-qualification testing procedure again during later production if the Engineer feels such action is appropriate.

After pre-qualification approval, inspect, sample and test actual bearing production as outlined below:

Have the manufacturer furnish certified laboratory test results on the elastomer properties of each batch or lot of compound used in the manufacture of bearings, both plain and laminated. Submit one sample bearing for each batch or lot of compound for verification testing.

SECTION 1080
PAINT AND PAINT MATERIALS

1080-1 GENERAL

Deliver all paints except two component products to the project completely mixed and ready for use without additional oil or thinner. Mix two component paints in accordance with the manufacturer's printed instructions and shall not need additional oil or thinner upon mixing, except where necessitated by weather conditions. Mixed paints or paint components that harden or curdle in the container and will not break up with a paddle to form a smooth, uniform consistency will be rejected. Any thinning necessitated by weather conditions shall be approved in writing and use only those thinners approved by the manufacturer. Store all paint materials in a moisture free environment between 40°F and 110°F or at such temperatures within this range recommended by the manufacturer.

1080-2 PAINT VEHICLES, THINNERS, AND DRIERS

Paint vehicles, thinners, and dryers shall meet the requirements for these ingredients that are included in the Specifications for the paint being used. Only ingredients recommended by the manufacturer which have a history of compatibility with each other may be used.

1080-3 PACKING AND MARKING

Ship paint and paint materials in strong, substantial containers, that are properly labeled and plainly marked with the weight, color, and volume in gallons of the paint content; a true statement of the percentage composition of the pigment; the proportions of pigment to vehicle; and the name and address of the manufacturer. Any package or container not so marked as described above or exceeding 5 gallons total volume will not be accepted for use.

1080-4 INSPECTION AND SAMPLING

Inspection and sampling will be made at the point of manufacture wherever possible. The right is reserved to sample all paint, either at the destination or at the point of origin, and to withhold acceptance of the paint until analysis of such samples have been made.

Use only pre-qualified inorganic zinc paint manufactured in accordance with the requirements shown below.

Have the paint manufacturer submit the following at the same time to the State Materials Engineer:

(A) A minimum one quart sample of each component of paint including the manufacturer's name, location, product name, mixing instructions, batch number, and MSDS information.

(B) A minimum of three panels prepared as specified in 5.5.10 of AASHTO M-300, Bullet Hole Immersion Test.

(C) A certified test report from an approved Independent Testing Laboratory for the Salt Fog Resistance Test and Cyclic Weathering Resistance Test specified in 5.5.8 and 5.5.9 of AASHTO M-300, respectively.

(D) A certified report from an approved Independent Testing Laboratory that the product has been tested for Slip Coefficient and meets the requirements set forth for AASHTO M253 Class B.

Use the same batch of paint for all samples and panels. The Independent Testing Laboratory Report may be for a typical batch of the same product. Submit samples and reports for qualification at least 30 days in advance of anticipated need. Once qualified, a product will be placed on North Carolina's approved list for a period of 5 years unless the formulation of the product or manufacturing process is changed, in which case the product shall be requalified before use.

The Materials and Tests Unit will conduct all tests of paints in accordance with the latest test methods of the American Society for Testing and Materials, Federal Test Method Standard No. 141, and various other methods in use.

1080-5 RED PRIMER PAINT

(A) SCOPE

This Specification covers a long oil-alkyd primer paint for use on steel surfaces blast-cleaned to a SSPC SP-6 finish. The paint may be applied by brushing or spraying to a wet film thickness of approximately 3 wet mils per coat.

(B) MATERIALS

Materials shall be as specified herein. Materials not specified shall be selected by the supplier and will be subject to all of the requirements of this Specification. Use paint made of materials that are not toxic to personnel under normal conditions of use and which contain no more than 2.8 pounds per gallon volatile organic compounds.

(1) PAINT CHARACTERISTICS

	MINIMUM	MAXIMUM
Pigment % by weight	53	55
Vehicle % by weight		47
Weight per gallon	12.9 lbs.	
Solids % by volume	67.0	
Fineness of grind Hegman units	4.5	
Moisture content % by weight		0.5
Skinning hrs (3/4 vol. in closed container)	48	
Viscosity	85 KU	95 KU
Drying time, set to touch		6 Hrs
Drying time, dry through		18 Hrs
* Adhesion at 14 days (ASTM D-3359)	3B	
Volatile Organic Compounds per Gallon		2.8 lbs.

(2) PIGMENT COMPOSITION (% by weight)

	MINIMUM	MAXIMUM
Zinc Hydroxy Phosphite ASTM D-4462-85	73	
Red Iron Oxide (86% Fe2O3)	24	
Organo Montmorillonite		1

(3) VEHICLE COMPOSITION (% by weight)

	MINIMUM	MAXIMUM
Non-Volatile	62	
Alkyd resin solids Fed. Spec TT-4-266, Type 1, Class A	40	
Linseed oil (ASTM D-234)	20	
Linseed oil to Alkyd ratio	1.2	
Thinner and Dryer Thinner: Fed. Spec. TT-T291, Type 2 Gr. A Dryer: Fed. Spec. TT-D-643B	38	

* Prepare the specimen for the adhesion test by applying two dry mils of the coating to a standard *Q* panel.

1080-6 ALKYD FINISH PAINT

(A) SCOPE

This Specification covers a gray, long oil-alkyd primer paint for use over surfaces coated with Red Alkyd Primer Paint. The paint may be applied by brushing or spraying to a wet film thickness of approximately 3 wet mils per coat.

(B) MATERIALS

Materials shall be as specified herein. Materials not specified will be selected by the supplier and be subject to all of the requirements of this Specification. Use paint

made of materials which are not toxic to personnel under normal conditions of use and which contain no more than 3.5 pounds per gallon volatile organic compounds.

(1) Paint Characteristics

	MINIMUM	MAXIMUM
Pigment % by weight	47	
Vehicle % by weight		54
Weight per gallon	11.0 lbs.	
Solids % by volume	54.0	
Fineness of grind Hegman units	6.0	
Moisture content % by weight		0.5
Skinning hrs (3/4 vol. in closed container)	48	
Viscosity	90 KU	100 KU
Drying time, set to touch		6 Hrs.
Drying time, dry through		18 Hrs.
* Adhesion at 14 days (ASTM D-3359)	3B	
Volatile Organic Compounds per Gallon		3.5 lbs.
Lead Content % by Weight Dry Film		0.05
Color (Federal Color Standard 595)	26622 (Gray)	

(2) Pigment Composition (% by weight)

	MINIMUM	MAXIMUM
Zinc Hydroxy Phosphite ASTM D-4462-85	20	
Titanium Dioxide ASTM D476 TY-II	50	
Magnesium Silicate	15	
Tinting and Inert Pigments		12

(3) Vehicle Composition (% by weight)

	MINIMUM	MAXIMUM
Non-Volatile	62	
Alkyd resin solids Fed. Spec. TT-4-266, Type 1, Class A	40	
Linseed oil (ASTM D-234)	20	
Linseed oil to Alkyd ratio	1.2	
Thinner and Dryer Thinner: Fed. Spec.TT-T291, Type 2 Gr. A Dryer: Spec. TT-D-643B	38	

* Prepare the specimen for the adhesion test by applying two dry mils of the coating to a standard *Q* panel.

1080-7 SELF-CURING INORGANIC ZINC PAINT

Use a self curing inorganic zinc paint meeting the requirements of a Type I Inorganic Zinc Primer paint specified in AASHTO M-300 and:

(A) Use mixed paint with zinc content of not less than 72 percent by mass of the total solids.

(B) The Slip Coefficient meets the requirements set forth for AASHTO M253 Class B.

(C) The elcometer adhesion when performed in accordance with ASTM D-4541 shall be no less than 400 psi.

(D) Cure the paint to meet the solvent rub requirements in ASTM D 4752.

(E) Formulate the paint so as to produce a distinct contrast in color with the blast cleaned metal surfaces and with the finish paint.

1080-8 COAL TAR EPOXY PAINT

Use coal tar epoxy paint meeting the requirements of Steel Structures Painting Council SSPC Paint 16.

1080-9 ORGANIC-ZINC REPAIR PAINT

Use organic-zinc repair paint meeting the requirements of SSPC Paint 20 Type II, or Federal Specification TT-P-641. Organic-zinc repair paint is not tinted and is applied 3 – 4 wet mils of paint per coat. Do not use zinc paint in aerosol spray cans.

1080-10 WASH PRIMER PAINT

Use wash primer paint meeting the requirements of Society of Protective Coatings SSPC Paint 27.

1080-11 BLANK

1080-12 WATERBORNE PAINTS

(A) Paints

(1) Waterborne Primer Paints The chemical requirements of the brown and white primer paints are specified in Tables 1080-1(A) through (D). Use primer paints on roughened steel surfaces cleaned to an SSPC SP-6 finish. Two coats of paint are required to form an effective primer coat. The first coat is brown and the second is white. Each coat is applied at a wet film thickness of approximately 6 mils.

(2) Waterborne Finish Paints The chemical requirements of the gray and green finish paints are specified in Tables 1080-2(A) through (D). Apply finish paints over compatible primer paints. Apply either one or two coats at a wet film thickness of approximately 6 mils each to produce an effective finish coat.

(B) Description

(1) The acrylic paints furnished in accordance with this Specification are one component products made from acrylic resins with sufficient additives, coalescing agents, solvents and pigmentation to produce a durable paint with a volatile organic compound (VOC) content less than 2.0 lb./gal.

(2) These products are intended for brush, roller or spray application applied in accordance with *SSPC-PA 1, Shop, Field and Maintenance Painting*.

(C) Composition

(1) Use ingredients and proportions as specified in Tables 1080-1(A) through (D) and 1080-2(A) through (D).

(2) Provide raw materials based on the specified ingredients that are uniform, stable in storage, and free from grit and coarse particles. Do not use rosin or rosin derivatives. Beneficial additives such as anti-skinning agents, suspending agents, or wetting aids are allowed.

(D) Properties

(1) Use both Type I and II paints that meet the requirements of Tables 1080-1(A) and (D) and 1080-2(A) through (D) and of Sections 5.2 - 5.8.

(2) Odor

Normal for the materials permitted (ASTM D 1296).

(3) Color

(a) Waterborne Primer Paint

The color before and after weathering when compared with Fed. Std. 595B is Brown #30045 for Type I (See Note 10.2). There are no color requirements for the White Primer.

(b) Waterborne Finish Paint

The colors before and after weathering when compared with Fed. Std. 595B are Green #24108 for Type I and Gray #26622 for Type II. (See Note 10.2)

(4) Working Properties

Use a paint that is easily applied by brush, roller, or spray when tested in accordance with Fed-Std - 141, Methods 4321, 4331, and 4541. Ensure that the paint shows no streaking, running, or sagging during application or while drying.

(5) Condition In Container

Ensure that the paint shows no thickening, curdling, gelling, or hard caking when tested as specified in Fed-Std - 141, Method 3011, after storage for six months from the date of delivery, in a full, tightly covered container, at a temperature of 50 - 110^{o} F.

(6) Skinning

No skinning is allowed in a three-quarters filled closed container after 48 hours when tested in the standard manner specified in Fed-Std - 141, Method 3021.

(7) Salt Contamination

Minimize the content of salt contamination by the incorporation of only high purity materials. Ensure that the specific resistance of the aqueous leachate of

the composite of the pigments in required proportions is a minimum of 5,000 ohm-cm when tested in accordance with ASTM D 2448.

(8) Early Rust Resistance

Provide each type of paint that meets the early rust requirements specified in Materials and Tests Standards CLS-P-1.0.

(9) Directions For Use

Supply the following directions for use with each container of paint:

Waterborne primer paint is intended for use as a primer over rough, bare structural steel. It is not intended for use over other paint systems. Waterborne finish paint is intended for use as a topcoat over a compatible primer in atmospheric exposure. Mix the paint thoroughly before use. For roller, brush, or airless spray application, no thinning should be necessary. A minimum amount of thinning may be necessary for conventional air spray. Apply by brush or spray to the specified film thickness or, if none is specified, to at least 2 mils dry or approximately 6 mils wet. Dry the surface to be painted and ensure that the surface temperature is a least 5^{o} F above the dew point, the humidity is less than 85%, and the temperature of the air is over 50^{o} F. Do not paint outdoors in rainy weather or if freezing temperatures are expected before the paint dries. Allow the paint at least 24 hours drying time before recoating.

(E) INSPECTION

(1) All materials supplied under this Specification are subject to random inspection by the Department. The Department has the right to reject any materials supplied that are found to be defective in accordance with Articles 105-3 and 106-9.

(2) Supply samples of any or all ingredients used in the manufacture of this paint, along with the supplier's name and identification for the material when requested.

(F) VOLATILE ORGANIC COMPOUND (VOC) CONTENT

Ensure that the VOC content after formulation (but before thinning) complies with the VOC limit for the applicable coatings category per Federal regulations. Make the coating specifier aware that more stringent state or local regulations may reduce the maximum VOC content permitted for coatings applied in a specific locality.

(G) COLOR VARIATION

A color variation of 5 delta e units from the specified color shall be acceptable. After three months weathering the color shall not vary more than 5 delta e units from the original color value.

TABLE 1080-1(A)
ANALYSIS FOR WATERBORNE PRIMER PAINTS

	REQUIREMENTS		
CHARACTERISTICS	**Min Wt %**	**Max Wt %**	**ASTM**
Pigment Content Type I (Brown) Type II (White)	 20 35	 25 40	D 3723
Volatiles Type I (Brown) Type II (White)	 - -	2.0 lbs./gal	D 2369
Coarse particles and skins, as retained on standard 325 mesh screen	-	0.5	D 185
Rosin or rosin derivatives	-	0	D 1542

TABLE 1080-1(B)
COMPOSITION OF WATERBORNE PRIMER PAINTS

	TYPE I	**BROWN**	**TYPE II**	**WHITE**	**TEST METHODS**
PIGMENTS	Wt % Min	Wt % Max	Wt % Min	Wt % Max	ASTM/Federal/State
Major Pigments	20	25	35	40	D 3723
Calcium Carbonate		-	30		D 1159
Magnesium Silicate				12	D 605
Titanium Dioxide		-	45	-	D 476, Type II
Zinc Phosphate	10	-	10	-	NCDOT M&T P-10
Iron Oxide	45				ASTM D 3721
Tinting Pigments					
Lamp Black		-	2%	-	ASTM D 209
Phthalocyanine Pigments				2%	ASTM D1135 & D3256
Acid Soluble Pigments[1]	-	-	-	0	
Lead	-	0.005	-	0.005	

TABLE 1080-1(C)

VEHICLE	Wt % Min	Wt % Max	Wt % Min	Wt % Max	**TEST METHODS**
Total Vehicle	73	80	60	65	NCDOT M&T P-10
HG-56 [3] Solids	30	-	30	-	
Water	-	55	-	55	
Methyl Carbitol	5	-	5	-	
Texanol	2	-	2	-	

1. Use a 5% acetic acid solution with a pH 4 $\pm$ 2 to determine solubility.
2. Do not use chrome green.
3. Or approved equivalent.

TABLE 1080-1(D)
PROPERTIES OF WATERBORNE PRIMER PAINTS

CHARACTERISTICS	R E Q U I REMENTS		ASTM/FEDERAL
	MIN	MAX	
Consistency* Sheer Rate 200 r/min			D 562
Ounces	255	350	
Krebs units	3.2	3.5	
Density, lb./US gal			D 1475
Type I (Brown)	9.7	-	
Type II (White)	11.0	-	
Fineness of Grind, Hegman Units	5.0	-	D 1210
Drying Time, Hours			D 1640
Tack Free	-	3	
Dry Hard	-	24	
Flash Point, ^{o}F	Report Value	Report Value	D 3278
Early Rust	9	-	Section 5.8
Leneta Sag Test	10+		
Gloss, Specular @ 60 degrees	Report Value	Report Value	
pH	8.0	8.5	
Adhesion (1)	4B		D 3359
Color	FED-STD 595B		
Type I (Brown)	30045		D 2244
Type II (White)	NA		

(1) Prepare the specimen for adhesion by applying 2 dry mils of coating to a 3”x 5”x 0.25” steel panel cleaned to a minimum SSPC SP-6 finish with a 1.7 $\pm$ 0.5 mil profile.

* Consistency 48 hours or more after manufacture.

TABLE 1080-2(A)
ANALYSIS FOR WATERBORNE FINISH PAINTS

	REQUIREMENTS		
CHARACTERISTICS	**Min Wt %**	**Max Wt %**	**ASTM**
Pigment Content			D 3723
Type I (Green)	13	17	
Type II (Gray)	13	17	
Volatiles		2.0 lbs./gal	D 2369
Type I (Green)	-		
Type II (Gray)	-		
Coarse particles and skins, as Retained on standard 325 mesh screen	-	0.5	D 185
Rosin or rosin derivatives	-	0	D 1542

TABLE 1080-2(B)
COMPOSITION OF WATERBORNE FINISH PAINTS

	TYPE I	GREEN	TYPE II	GRAY	TEST METHODS
PIGMENTS	Wt % Min	Wt % Max	Wt % Min	Wt % Max	ASTM/Federal/State
Major Pigments	13	17	13	17	D 3723
Calcium Carbonate		-			D 1159
Magnesium Silicate					D 605
Titanium Dioxide	5	-	70	-	D 476, Type II
Zinc Phosphate	10	-	10	-	NCDOT M&T P-10
Tinting Pigments					
Lamp Black					ASTM D 209
Phthalocyanine Green	0	-	0	-	ASTM D 3021
Red Iron Oxide					ASTM D 3721
Yellow Iron Oxide					ASTM D 768
Acid Soluble Pigments[1]	-	-	-	0	
Lead	-	0.005	-	0.005	

TABLE 1080-2(C)

VEHICLE	Wt % Min	Wt % Max	Wt % Min	Wt % Max	TEST METHODS
Total Vehicle	83	87	83	87	NCDOT M&T P-10
HG-56 [3] Solids	30	-	30	-	
Water	-	58	-	58	
Methyl Carbitol	5	-	5	-	
Texanol	4	-	4	-	

1. Use a 5% acetic acid solution with a pH 4 $\pm$ 2 to determine solubility.
2. Do not use chrome green.
3. Or approved equivalent.

TABLE 1080-2(D)
PROPERTIES OF WATERBORNE FINISH PAINTS

	REQUIREMENTS		
CHARACTERISTICS	**MIN**	**MAX**	**ASTM/FEDERAL**
Consistency* Sheer Rate 200 r/min			D 562
Grams	255	350	
Krebs units	90	100	
Density, lb./US gal			D 1475
Type I (Green)	9.35	-	
Type II (Gray)	9.35	-	
Fineness of Grind, Hegman Units	5.0	-	D 1210
Drying Time, Hours			D 1640
Tack Free	-	3	
Dry Hard	-	24	
Flash Point, ^{o}F	Report Value	Report Value	D 3278
Early Rust	9	-	Section 5.8
Leneta Sag Test	10+		
Gloss, Specular @ 60 degrees	40		
pH	8.0	8.5	
Adhesion (1)	4B		D 3359
Color	Fed-Std 595B		
Type I (Green)	24108		D 2244
Type IB(NC Green)	24272		
Type II Gray)	26622		

(1) Prepare the specimen for adhesion by applying 2 dry mils of coating to a 3”x 5”x 0.25” steel panel cleaned to a minimum SSPC SP-6 finish with a 1.7 $\pm$ 0.5 mil profile.
*Consistency 48 hours or more after manufacture.

1080-13 BLANK

1080-14 PAINT FOR VERTICAL MARKERS

For vertical markers, use a waterborne acrylic or alkyd type material meeting the following requirements:

(A) Color...Federal Color Std. 595 ……# 27040 Black or # 13538

(B) Adhesion to Substrate (ASTM D3350) …… 3A Min.

Apply sufficient paint to completely cover the color of the underlying substrate along with any surface imperfections.

1080-15 ABRASIVE MATERIALS FOR BLAST CLEANING STEEL

Select the gradation of the abrasive to impart the anchor profile specified.

Alternative A - Expendable Abrasive

Use blasting abrasives with a suitable steel or mineral abrasive which contain no more than 100 ppm of any corrosive compound such as sulfate or chloride or 100 ppm of any EPA characteristic waste compound such as lead, chromium, or arsenic.

Alternative B - Recyclable Steel Grit

Use abrasives that when sampled at any time during the blasting process, contain no more than 100 ppm of any corrosive compound such as sulfate or chloride or 1000 ppm of any EPA characteristic waste compound such as lead, chromium or arsenic. Maintain the size and shape of the abrasive to impart the specified profile.

1080-16 FIELD PERFORMANCE AND SERVICE

Do not use paint products inspected by the Engineer and found to exhibit poor performance in similar North Carolina environments. *Poor performance* is defined as any coating failing to meet ASTM D610, Grade 5, or having greater than 3% rusting or disbonding before attaining 5 years of service.

SECTION 1081
EPOXY AND ADHESIVES

1081-1 EPOXIES - GENERAL

The types of epoxies and their uses are as shown below:

Type 1. A low-modulus, non-sag gel adhesive used to bond or repair damp, vertical, or overhead surfaces. Typical applications include walls, concrete foundations, concrete pipe, conduit, and ceilings.

Type 2: A low-modulus, general-purpose adhesive used in epoxy mortar repairs and broadcast sand sealing operations. Bridge Maintenance uses it as both a primer coat and thickness-building second coat in two-stage sand broadcast operations to seal and skid-proof bridge decks. As a repair material, it may be used to patch spalled, cracked, or broken concrete where vibration, shock, or expansion and contraction is expected. Feather-edged patching is not recommended with this material; instead, the adjacent concrete perimeter should be sawed at least 1/4" to 1/2" deep and any remaining concrete chipped away to provide a vertical interface between the epoxy mortar and concrete.

Type 3. A high-modulus general-purpose adhesive used to bond plastic concrete or hardened concrete to hardened concrete or other structural materials. It may also be used to produce a high-strength epoxy mortar grout bed for equipment or to patch interior spalls, cracks, or broken concrete. It is not recommended for exterior patching because its rate of thermal expansion and contraction differs too greatly from concrete. It may be used for anchoring bolts where a flowable adhesive is required.

Type 3A. A gel-like version of Type 3, used specifically for embedding dowel bars, threaded rods, rebars, and other fixtures in hardened concrete. The manufacturer shall submit test results showing that the bonding system will obtain 125% of the specified yield strength of the anchor fixture in concrete with a minimum compressive strength of 3000 psi. Plans may call for field testing of adhesively anchored fixtures.

Type 4A. A gray protective coating for concrete, wood, steel and other structural materials. It is typically used as a topcoat in waterproofing concrete exposed to splash zones and tidal water.

Type 4B. A red primer coating used with Type 4A.

Type 5. A high modulus, low viscosity adhesive suitable for pressure injection into cracks in concrete. For some non-structural crack repairs, Type 5 epoxy may be poured on the surface to penetrate cracks by gravity. This may be beneficial before waterproofing and skid proofing.

Type 6A. An adhesive for bonding raised traffic markers to concrete or asphalt surfaces. Part A shall be pigmented white, Part B black so that when the components are combined a uniform gray color results.

Type 6B. A normal-setting self-leveling adhesive for bonding traffic markers in recessed areas on concrete and asphalt. Type 6A color requirements apply.

Type 6C. A rapid-setting adhesive for bonding traffic markers to concrete and asphalt surfaces. Type 6A color requirements apply.

1081-2 SPECIFICATIONS FOR USE OF EPOXIES

(A) Supply

Supply epoxy resin in two components, labeled as Component A -- Contains Epoxy Resin and Component B -- Contains Curing Agent, for combining immediately prior to use in accordance with the manufacturer's instructions. Mark each container with the manufacturer's name, NCDOT type, lot or batch number, quantity, date of manufacture, shelf life or expiration date, color, mixing instructions, usable temperature range, and hazards or safety precautions.

Furnish the two components in separate non-reactive containers. Provide containers of such size that the proportions of the final mix can be obtained by combining a single container of one component with one or more whole containers of the other component.

(B) Acceptance

The Materials and Tests Unit maintains an approved list of epoxies identified by brand name and Department type. When materials on this list are furnished to a project, submit to the Engineer a Type 1, Certified Mill Test Report for each lot or batch. Materials not on this list shall be tested by the Department prior to use, in which case the manufacturer shall furnish samples and a Type 1 certification to the Materials and Tests Unit. The sample size for a 1:1 mix ratio will be one gallon per component; for different mix ratios, the sample size of the greater component will be increased proportionally. When materials are furnished to the Bridge Maintenance Unit, the terms of acceptance will be listed in the bid solicitation. The Engineer reserves the right to reject any epoxy that does not perform adequately in the field.

(C) Fillers, Pigments, and Thixotropic Agents

All integral fillers, pigments, and thixotropic agents shall be fine enough to not separate, settle, or cause skinning during storage of the epoxy components. Do not

use abrasive fillers such as alumina and silica flour. Do not use solvents. When mineral fillers are to be added during mixing, they shall be inert, readily dispersible, and, except for sand, have fineness such that 99% of the material will pass a No. 325 sieve.

(D) Shelf life

The shelf life of parts A and B shall be a minimum of 1 year from the date of manufacture.

1081-3 NOTES ON USE OF EPOXIES

(A) Moisture Conditions

Types 1 - 5 are moisture insensitive and can be applied on clean, dry, or damp surfaces free of standing water.

(B) Coefficient of Expansion

The coefficient of expansion of cured epoxy is 6 times greater than that of concrete. Therefore, to reduce spalling and peeling during temperature changes, avoid thick layers of pure epoxy. A 4:1 by weight sand-epoxy mortar has approximately the same coefficient of expansion as concrete.

(C) Safety

Epoxies can irritate the eyes, skin, and respiratory tract. Therefore, wear chemical splash goggles, chemically-resistant gloves, and protective clothing and boots when handling epoxies. Respiratory protection is usually not needed if epoxies are mixed and applied in well-ventilated areas, but avoid prolonged breathing of vapors. Follow all Material Safety Data Sheet instructions for proper use of these materials.

(D) Mixing

Stir parts A and B individually until each component is homogeneous. Use a separate stirrer for each component.

Combine parts A and B, either by weight or volume, as specified in the manufacturer's instructions. Stir the mixture vigorously, periodically scraping the sides and bottom of the container. Small quantities of epoxy usually require 2-3 minutes to mix homogeneously; 5-gallon quantities can take up to 10 minutes of mixing.

Temperature affects the viscosity and pot life of epoxies. Most laboratory tests are conducted at 77°F. Higher temperatures render epoxies thinner and faster setting; lower temperatures induce higher viscosities and longer pot lives.

Add sand or other fillers to liquid epoxies only after parts A and B have been thoroughly mixed. Stir in the sand or filler until all particles are completely coated.

(E) Storage and Substrate Temperature

Store epoxies at temperatures between 50°F and 90°F. Epoxy components exposed to the extremes of this range or outside this range should be conditioned to 77°F

before mixing and blending. If heat is necessary, always use indirect methods such as hot water, a heated room, or a microwave oven to condition components.

When applying epoxy to a cold substrate, preheat the components approximately 1°F above 77°F for every 2°F of substrate temperature below 77°F.

Seal previously opened containers to be airtight. Unsealed containers can absorb moisture from the atmosphere, which can alter the chemical reaction of the mixture.

1081-4 TEST METHODS FOR EPOXIES

(A) Viscosity

Determine the viscosity of the mixture in accordance with ASTM D 2669, using Brookfield viscometer model RVT. Use the spindle number and speed shown in Table 1081-1.

(B) Pot Life

Determine the pot life of the mixture in accordance with AASHTO T 237 except use a mass of 60 + or - 0.4g.

(C) Compressive Strength of Epoxy Mortar

Determine the compressive strength of epoxy mortar in accordance with ASTM C 109 except as follows:

Use mortar consisting of one part epoxy and three parts standard graded Ottawa sand except for Types 1 and 3A, which shall be tested neat. Mix epoxy components A and B at the recommended proportions for 2 minutes, add the sand, and mix for 3 minutes. Pour the mortar into the cube molds in 2 layers, and tamp each layer 50 times with a spatula and 25 times with a hammer handle. Make 6 specimens, and cure all in air at 77 + or - 2°F for 24 hours. Test 3 specimens for compressive strength at the end of this curing period. Immerse the remaining 3 specimens in water at $\pm$ 77°F for 6 days, after which immediately test them for compressive strength in the wet condition.

(D) Volatiles Content

Determine the percentage of volatiles in the mixture in accordance with ASTM D 1078.

(E) Ash Content

Determine the ash content of the mixture in accordance with ASTM D 482.

(F) Tensile Strength and Tensile Elongation

Determine the tensile strength and tensile elongation of the mixture in accordance with ASTM D 638.

(G) Hardness

Determine the Shore D hardness of the mixture at 24 hours and 7 days in accordance with ASTM D 2240.

(H) Absorption

Determine the water absorption of the mixture in accordance with ASTM D 570.

(I) Bond Strength

Determine the bond strength of the moist-cured mixture at 14 days by the slant shear test, ASTM C 882.

1081-5 PROPERTIES OF EPOXIES

Epoxies shall conform to the requirements shown in Table 1081-1.

1081-6 POLYESTER RESIN EPOXY ADHESIVE

(A) General

Polyester resin is used specifically for embedding dowel bars, threaded rods, rebars, and other fixtures in hardened concrete.

Have the manufacturer submit test results showing that the bonding system will obtain 125% of the specified yield strength of the anchor fixture in concrete with a minimum compressive strength of 3000 psi. Field testing may be required for adhesively anchored fixtures.

(B) Materials

Package components of the adhesive in containers of such size that one whole container of each component is used in mixing one batch of adhesive. Use containers of such design that all of the contents may be readily removed, and are well sealed to prevent leakage. Furnish adhesive material that requires hand mixing in two separate containers designated as Component A and Component B. A self contained cartridge or capsule will consist of two components which will be automatically mixed as they are dispensed, as in the case of a cartridge, or drilled into, as in the case of a capsule.

Clearly label each container with the manufacturer's name; date of manufacture; batch number; batch expiration date; all directions for use and such warning of precautions concerning the contents as may be required by State or Federal Laws and Regulation.

(C) Mixing of Adhesive

Mix adhesive in strict conformance with the manufacturer's instructions.

1081-7 HOT BITUMEN

The adhesive shall be an asphaltic material with a homogeneously mixed filler and comply with the following requirements:

(A) Physical Requirements

(1) Adhesive Properties determined on the asphaltic material with filler.

	MIN.	MAX.	TEST METHOD
Softening point, °F.	200	--	ASTM D 36
Penetration, 100 g., 5 sec., 77 °F	10	18	ASTM D 5
Flow, Inch	--	0.2	ASTM D 5329 (as modified in test methods)
Viscosity, 400 °F, Poises	--	75	ASTM D 2669 or D 4402 (as modified in test methods)
Flash Point, C.O.C., °F.	550	--	ASTM D 92

(2) Asphalt Properties determined on the filler-free material derived from the extraction and Abson recovery process as explained in Test Methods.

	MIN.	MAX.	TEST METHOD
Penetration, 100 g., 5 sec., 77 °F	25	--	ASTM D 5
Viscosity, 275 °F Poises	12	-100	ASTM D 2171
Viscosity Ratio, 275 °F	2.2		(as explained in test methods)

(3) Filler Properties determined using the filler separation techniques described in Test Methods.

	MIN.	MAX.	TEST METHOD
Filler Content, % by weight,	65	75	(as described in test methods)
Filler Fineness, % passing			ASTM C 430
No. 325	75		(as modified
No. 200	95		in test
No. 100	100		methods)

(B) Test Methods

(1) Flow

Determine flow according to Section 6, Flow, of ASTM D 3407 with the exception that the oven temperature shall be 158 ± 2 °F and sample preparation done according to Section 7.1 of ASTM D 5.

(2) Viscosity

Viscosity is to be determined according to ASTM D 2669 using a spindle speed of 10 rpm. Heat the adhesive to approximately 410°F and allowed to cool. Determine viscosity at 400 ± 1°F.

(3) Asphalt Properties

Properties of the base asphalt are to be determined on the material obtained from the following extraction and Abson recovery methods. Extract the asphalt by heating the adhesive just to the point where it will easily flow and then transfer 125 to 150 grams into 400 ml of trichloroethylene with a temperature of 125°F to 150°F to 66°C). Thoroughly stir this mixture to dissolve the asphalt. Decant the trichloroethylene-asphalt mixture decanted and the asphalt recovered using the Abson recovery method, ASTM D 1856 as modified by the following. The extraction methods of ASTM D 2711 do not apply and there will be no filtration of the solvent asphalt mixture. The extraction solution of trichloroethylene and asphalt shall be centrifuged for at least 30 minutes at 770 times gravity in a batch centrifuge. Decant this solution in the distillation flask, taking care not to include any filler sediment. Apply heat and bubble carbon dioxide solution slowly to bring the solution temperature to 300°F. At this point the carbon dioxide flow is increased to 800 to 900 ml per minute. The solution temperature is maintained at 320°F to 335°F with this carbon dioxide flow for at least 20 minutes and until the trichloroethylene vapors have been completely removed from the distillation flask. Repeat the above extraction-recovery method as necessary to obtain the desired quantity of asphalt. Use the asphalt recovered to determine penetration, 275°F viscosity, and 275°F viscosity ratio.

(4) Viscosity Ratio

Determine the 275°F viscosity ratio by comparing the 275 °F viscosity on the base asphalt before and after the Thin-Film Oven Test. Perform the Thin-Film Oven Test as in ASTM D 1754. Determine the specific gravity by pycnometer as in ASTM D 70 for use in the Thin-Film Oven Test. Calculate the 275°F viscosity ratio by dividing the viscosity after the Thin-Film Oven Test by the original 275°F viscosity.

(5) Filler Material

Separate the filler material from the asphalt to determine Filler Content and Filler Fineness. Determine the portion by weight of the adhesive insoluble in 1,1,1-trichloroethane by weighing 10.00 ± 0.01 grams of solid adhesive into a centrifuge flask with approximately 100 ml volume such as that specified in ASTM D 1796. Add 50 ml of 1,1,1-trichloroethane to the adhesive, which should be broken up in small pieces in order to speed up the dissolution solids. Place the sample flask in a balanced centrifuge and spin using a minimum relative centrifugal force of 150 (as determined in Section 6 of ASTM D 1796) for 10 minutes. Remove the sample flask and decant the solid, taking care not to lose any solids. Repeat the application of solvent and centrifuging until the solvent becomes clear and the filler is visually free of asphalt. Dry the filler at 160 ± 5°F to remove solvent and weigh the resulting filler. Filtration of the decanted solvent may be performed to verify there is no loss of filler. Percent filler content is calculated as follows:

$$\text{Filter Content, \% by weight} = \frac{\text{(Filler, Wt, gm.) (100)}}{\text{Original Adhesive Wt., gm.}}$$

Determine Filler Fineness according to ASTM C 430 using number 325, 200 and 100 sieves. This method is to be modified by using a water soluble non-ionic wetting agent, such as Triton X-100, to aid the wetting action. Concentration of the surfactant solution shall be approximately 1% by weight. Thoroughly wet the one-gram dry sample in the surfactant solution and allowed to soak for 30 minutes. Transfer the filler completely into the sieve cup and apply water spray for 2 minutes. Surfactant solution may be added as needed and physical means used to disperse any clumped particles. Dry the sample and handle as described in ASTM C 430.

(C) Prequalification

Bituminous adhesives are required to be pre-qualified by the Department's Transportation-Traffic Engineering Branch. For more information on the pre-qualification process contact the Traffic Engineering Branch-Traffic Control Section.

(D) Packaging and Labeling

Pack the adhesive in self-releasing cardboard containers which will stack properly. Containers shall have a net weight of 50 to 60 pounds and contain 2 to 4 subcompartments. Have the label show the manufacturer, quantity, and batch number. Print *Bituminous Adhesive for Pavement Markers* or similar wording on the label.

(E) Certification

A certification from the manufacturer showing the physical properties of the bituminous adhesive and conformance with the Specifications will be required. Supply certification prior to use.

(F) Application

Apply the adhesive according to the manufacturer's requirements and the following requirements.

Apply the adhesive when the road surface, ambient air and pavement marker temperatures are in the range of 50°F to 160°F on dry pavement.

The composition of the adhesive shall be such that its properties will not deteriorate when heated to and applied at temperatures up to 425°F using either air or oil-jacketed melters.

Melt and heat the bituminous adhesive in either thermostatically controlled double boiler type units using heat transfer oil or thermostatically controlled electric heating pots. Do not use direct flame units.

Heat the adhesive to between 375°F and 425°F and applied directly to the pavement surface from the melter/applicator by either pumping or pouring. Maintain the

application temperature between 375°F and 425°F as lower temperatures may result in decreased adhesion while higher temperatures may damage the adhesive.

Use sufficient adhesive to insure total contact with the entire bottom of the pavement marker. Apply pavement markers to the adhesive immediately (within 5 seconds) to assure bonding. Place the pavement marker in position by applying downward pressure until the marker is firmly seated with the required adhesive thickness and squeeze-out. Remove excessive adhesive squeeze-out from the pavement and immediately remove adhesive on the exposed surfaces of pavement markers. Soft rags with mineral spirits conforming to Federal Specifications TT-T-291 or kerosene may be used if necessary, to remove adhesive from exposed faces of pavement markers. No other solvent may be used.

Do not waste or spill any excess adhesive on Department right-of-way. Remove and properly dispose of any adhesive spilled or dumped at such location. The Contractor at no cost to the Department will correct any damage incurred to the Department, highway or appurtenances as a result of misplaced adhesive.

The adhesive may be reheated and reused. However, the pot life at application temperatures shall not exceed the manufacturer's recommendations.

Clean out of equipment and tanks may be performed using petroleum solvents such as diesel fuel or similar materials. All solvents shall be removed from the equipment tanks and lines before the next use of the melter.

TABLE 1081-1
PROPERTIES OF EPOXY

TYPE PROPERTY	1 Min Max	2 Min Max	3 Min Max	3A Min Max	4A Min Max	4B Min Max	5 Min Max	6A Min Max	6B Min Max	6C Min Max
VISCOSITY-POISES @ 77°F ± 2°F ± (25°C ±1°C) SPINDLE NO. SPEED (RPM)	GEL	10 30 3 20	25 75 4 20	GEL	40 150 4 10	40 150 4 10	1 6 2 50	1500 3000 with helipath stand TD @ 5	400 800 6 10	1500 3000 with helipath stand @ 5
POT LIFE (MINUTES)	20 50	30 60	20 50	5 50	40 80	40 80	20 60	8 13	8 13	7 10
TENSILE STRENGTH PSI (MPa) AT 7 DAYS	1500	2000	4000	4000	1500	1500	4000			
TENSILE ELONGATION % AT 7 DAYS	30	30	2 5	2 5	5 15	5 15	2 5			
COMPRESSIVE STRENGTH: PSI (MPa) OF 2 in MORTAR CUBES @ 24 HRS. @ 7 DAYS	NEAT 3000 5000	4000	6000	NEAT 6000	3000	3000 5000	6000			
SHORE HARDNESS @ 24 HRS @ 7 DAYS	60 70	60 70	70 80	70 80	65 75	65 75	70 80			
WATER ABSORPTION % MAX.	1.5	1.0	1.0	1.5	1.0	1.0	1.0			
ASH CONTENT % MAX	30	2.0	2.0	50	10 30	10 30	2.0			
BOND STRENGTH SLANT SHEAR TEST: PSI (MPa) @ 14 DAYS	1500	1500	2000	2000	1500	1500	1500			

SECTION 1082
STRUCTURAL TIMBER AND LUMBER

1082-1 GENERAL

*A*ll timber and lumber shall be Southern Pine and be graded in accordance with the current grading rules of the Southern Pine Inspection Bureau unless otherwise specified or approved by the Engineer. Stress rated grades of Southern Pine other than those specified may be used provided the grades used have a stress rating equal to or higher than the grades specified, except that for temporary crossings, the use of stress rated lumber having stress ratings below those specified may be used subject to the approval of the Engineer.

Have all timber and lumber, including any preservative treatment, inspected and/or tested at no cost to the Department by an approved commercial inspection company before it is delivered to the project. Provide industry standard commercial inspection reports for each shipment of untreated timber or lumber prior to its use on the project. Provide industry standard commercial inspection reports and treatment test reports for each shipment of treated timber or lumber prior to its use on the project. Perform all timber and lumber treatment inspections in accordance with Standard M2 (Part A) of the AWPA Specifications. In addition, brand, hammer mark, ink stamp or tag each piece of timber or lumber with the approved commercial inspection company's unique mark to indicate it has been inspected.

1082-2 UNTREATED TIMBER AND LUMBER

Lumber that is 2" to 4" thick and 2" to 4" wide shall conform to the requirements for Structural Light Framing, Grade No. 1 Dense MC19. Lumber that is 2" to 4" thick and 6" wide and wider shall conform to the requirements for Structural Joists and Planks, Grade No. 1 Dense MC19. Lumber that is 5" and thicker along the least dimension shall conform to the requirements for Structural Lumber, Grade Dense Structural 72. Rough lumber will be acceptable except where surfacing is called for by the contract. Rough lumber may vary 1/4" plus or minus from the dimensions shown on the contract or bill of material.

1082-3 TREATED TIMBER AND LUMBER

(A) General

Grade marked lumber will not be required. Brand or ink stamp each piece of treated lumber in accordance with the American Wood Preservers Association Standard M6.

(B) Bridges, Fender Systems, and Piles

Lumber for bridges that is 2" to 4" thick and 2" to 4" wide shall conform to the requirements for Structural Light Framing, Grade No. 1 Dense. Lumber for bridges that is 2" to 4" thick and 6" wide and wider shall conform to the requirements for Structural Joists and Planks, Grade No. 1 Dense. Lumber for bridges that is 5" and thicker along the least dimension shall conform to the requirements for Structural Lumber, Grade Dense Structural 65. Lumber for fender systems shall conform to the requirements for Structural Lumber, Grade Dense Structural 65.

Timber for bearing piles shall meet the requirements of ASTM D25 except that the timber shall be Southern Pine, and have a minimum of a 2" sap ring or a 3" sap ring where called for by the contract or where the preservative is creosote and the retention is greater than 18 pounds per cubic foot.

Rough lumber will be acceptable except where surfacing is called for by the contract or bills of material. Rough lumber may vary 1/4" plus or minus from the dimensions shown on the plans or bill of material. Dressed lumber may be 1/8" scant from the dimensions shown on the plans or bill of material. A 1/4" tolerance in length will be permitted.

(C) Guardrail Posts

Lumber for guardrail posts shall conform to the requirements for Timbers, Grade No.1.

Rough lumber will be acceptable.

An allowable tolerance of 3/8" scant will be permitted from nominal dimensions.

(D) Fence Posts and Braces

Sawed fence posts and braces no larger than 4" by 4" shall conform to the requirements for Structural Light Framing, Grade No. 2. Sawed fence posts and braces larger than 4" by 4" shall conform to the requirements for Timbers, Grade No. 1.

Round lumber shall meet the requirements of Subarticle 1050-2(A).

Use fully dressed S4S lumber for fence posts.

An allowable tolerance of 1/2" scant will be permitted from nominal dimensions of sawed and dressed lumber.

(E) Sign Posts and Battens

Lumber for sign posts no larger than 4" by 4" shall conform to the requirements for Structural Light Framing, Grade No. 1 MC19. Lumber for sign posts larger than 4" by 4" and lumber for sign battens shall conform to the requirements for Timbers, Grade No. 1. Use fully dressed S4S lumber for sign posts and battens.

An allowable tolerance of 1/2" scant will be permitted from nominal dimensions of sign posts. A tolerance of 1" under and 3" over will be permitted in the length of the post.

(F) Poles

Timber for poles shall meet the requirements of ANSI O5.1 except the timber shall be treated Southern Pine or treated Douglas Fir. Use 40’ Class 3 poles unless otherwise specified in the contract.

1082-4 PRESERVATIVE TREATMENT

(A) General

Give all timber and lumber required to be treated a preservative treatment in accordance with Standard C1 of the American Wood-Preserver's Association. The required retetion of chromated copper arsenate is specified on the oxide basis. Preservative retention will be determined by the assay method.

After treatment, handle the timber and lumber carefully with rope slings, without sudden dropping, breaking of the fibers, bruising, or penetrating the surface with tools or hooks.

Treated timber and lumber will not be accepted for use unless it has been inspected and found satisfactory, both before and after treatment, and shall be delivered to the project site in a condition acceptable to the Engineer.

Use treating plants that have laboratory facilities at the plant site for use of the inspector in accordance with Standard C1 of the American Wood-Preserver's Association.

(B) Timber Preservatives

All timber preservatives shall conform to the requirements of Standard C1 of the American Wood-Preserver's Association.

(C) Bridges, Fender Systems, and Piles

Standard C2 of the American Wood-Preserver's Association will be applicable to the treatment of timber and lumber for bridges and fender systems, except that the type of preservative and the retention of preservative will be as required by the contract.

Standard C3 of the American Wood-Preserver's Association will be applicable to the treatment of piles, except that the type of preservative and the retention of preservative will be as required by the contract.

(D) Guardrail Posts

Standard C2 of the American Wood-Preserver's Association will be applicable to the treatment of guardrail posts, except that the required retention of preservative shall be as below.

Give all guardrail posts a preservative treatment of creosote, pentachlorophenol or chromated copper arsenate. The same type of preservative is to be used throughout the entire length of the project.

Minimum retention for creosoted timber will be 12 pounds of preservative per cubic foot of wood. Minimum retention for timber treated with pentachlorophenol will be 0.6 lb. of dry chemical per cubic foot of wood. Minimum retention for timber treated with chromated copper arsenate will be 0.6 lb. of dry chemical per cubic foot of wood.

(E) Fence Posts and Braces

Standard C2 of the American Wood-Preserver's Association will be applicable to the treatment of sawed posts and braces, except that the required retention of preservative will be as below.

Standard C5 of the American Wood-Preserver's Association will be applicable to the treatment of round posts and braces, except that the required retention of preservative will be as below.

Prior to treatment, peel round posts and braces cleanly for their full length, remove all bark and innerskin, and trim all knots and projections flush with the surface of the surrounding wood. Machine peeling will be permitted. Cut the ends to the proper length before treatment.

Give all fence posts and braces a preservative treatment of either creosote, pentachlorophenol, or chromated copper arsenate. The same type of preservative shall be used throughout the entire length of the project.

Minimum retention for creosoted sawed timber will be 10 pounds of preservative per cubic foot of wood. Minimum retention for sawed timber treated with pentachlorophenol will be 0.5 lb. of dry chemical per cubic foot of wood. Minimum retention for sawed timber treated with chromated copper arsenate will be 0.5 lb. of dry chemical per cubic foot of wood.

Minimum retention for creosoted round timber will be 8 pounds of preservative per cubic foot of wood. Minimum retention for round timber treated with pentachlorophenol will be 0.4 lb. of dry chemical per cubic foot of wood. Minimum retention for round timber treated with chromated copper arsenate will be 0.4 lb. of dry chemical per cubic foot of wood.

(F) Sign Posts and Battens

Standard C2 of the American Wood-Preserver's Association will be applicable to the treatment of sign posts and battens, except that the required retention of preservative will be as below.

Give all sign posts and battens a preservative treatment of either pentachlorophenol or chromated copper arsenate. The same type of preservative shall be used throughout the entire length of the project.

Minimum retention for timber treated with pentachlorophenol will be 0.6 lb. of dry chemical per cubic foot of wood. Minimum retention for timber treated with chromated copper arsenate will be 0.6 lb. of dry chemical per cubic foot of wood.

All timber shall have moisture content of not greater than 19 percent before treatment. Redry timber treated with chromated copper arsenate after treatment until it has moisture content of not greater than 25 percent.

(G) Poles

Standard C4 of the American Wood-Preserver's Association will be applicable to the treatment of poles, except that the required retention of preservative will be as below.

Give all poles a preservative treatment of either pentachlorophenol, or chromated copper arsenate. The same type of preservative shall be used throughout the entire length of the project.

Minimum retention for poles treated with pentachlorophenol will be 0.45 lb. by assay of dry chemical per cubic foot of wood. Minimum retention for poles treated with chromated copper arsenate will be 0.6 lb. by assay of dry chemical per cubic foot of wood.

SECTION 1084

PILES

1084-1 BEARING PILES

(A) Treated Timber Bearing Piles

Timber for treated timber bearing piles shall meet the requirements of Article 1082-3.

Give treated timber bearing piles a preservative treatment in accordance with Article 1082-4.

(B) Steel Bearing Piles

Prior to incorporating steel bearing piles into the work, obtain all applicable certified mill test reports clearly identifiable to the lot of material by heat numbers and submit these reports to the Engineer for review and analysis, and receive approval of such test reports from the Engineer. These requirements apply to both domestic and foreign produced steel bearing piles. Transfer the heat number of each painted pile to the newly painted surface with a permanent marker of a color contrasting to the paint once the paint has fully cured.

(1) Steel H Piles

Steel H piles shall meet the requirements of ASTM A572 Grade 50 or A588.

(2) Steel Pipe Piles

Steel pipe piles shall be of uniform diameter and conform to the requirements of ASTM A252 Grade 3 modified (50,000 psi). Make all joints and seams in the pipe pile watertight. Unless otherwise indicated by the contract, the ends of pipe pile may be flame cut. Square flame cut ends with axis of the pile so as to provide a full uniform bearing over the entire end area when the pile is being driven. Pipe piles under 24" in diameter shall be spliced by certified pipe welder.

(C) Prestressed Concrete Bearing Piles

Prestressed concrete bearing piles shall meet the requirements of Section 1078.

1084-2 SHEET PILES

(A) Treated Timber Sheet Piles

Timber for treated sheet piles shall meet the requirements of Article 1082-3.

Give timber for treated timber sheet piles a preservative treatment in accordance with Article 1082-4.

(B) Steel Sheet Piles

Steel sheet piles detailed for permanent applications shall meet the requirements of ASTM A690 unless otherwise required by the plans.

Steel sheet piles detailed for temporary applications shall meet the requirements of ASTM A328.

(C) Prestressed Concrete Sheet Piles

Prestressed concrete sheet piles shall meet the requirements of Section 1078.

SECTION 1086
PAVEMENT MARKERS

1086-1 TEMPORARY RAISED PAVEMENT MARKERS

(A) General

Use temporary raised pavement markers that have been evaluated by NTPEP.

Use temporary raised pavement markers of the prismatic reflector type, or better as approved. The markers shall be constructed either of an injection molded plastic body and base or consist of a plastic shell filled with a mixture of inert thermosetting compound and filler material. Either construction type shall contain one or more integrated prismatic reflective lenses to provide the required color designation.

The minimum reflective area of the lens face is 2.0 square inches.

The color of the reflective pavement marker housing shall match the pavement marking color, which it supplements.

All raised pavement marker reflective lenses shall be in close conformance with the Federal Standard No. 595 colors as listed below when viewed at night.

Crystal	Color No. 17886 (White)
Yellow	Color No. 13538
Red	Color No. 11302

(B) Adhesives

(1) Epoxy

The epoxy shall meet the requirements of Section 1081.

The two types of epoxy adhesive which may be used are Type 6A (Standard Setting), and Type 6C (Rapid Setting). Use Type 6A when the pavement temperature is above 60°F. Use Type 6C when the pavement temperature is between 50°F and 60°For when a very fast set is desirable. Epoxy adhesive Type 6C-Cold Set may be used to attach temporary pavement markers to the pavement surface when the pavement temperature is between 32°F and 50°F.

(2) Hot Bitumen

The Hot Bitumen shall meet the requirements of Article 1081-7.

(3) Pressure Sensitive

As supplied by the manufacturer.

(C) Material Certification

Furnish a Type 2 Certification in accordance with Article 106-3 for all raised pavement markers prior to use.

1086-2 PERMANENT RAISED PAVEMENT MARKERS

(A) General

Use raised pavement markers that have been evaluated by NTPEP. The markers shall be constructed either of an injection molded plastic body and base or consist of a plastic shell filled with a mixture of inert thermosetting compound and filler material. Either construction type shall contain one or more integrated prismatic reflective lenses to provide the required color designation. Raised pavement markers (permanent) shall be of the glass or plastic face lens type and meet the requirements of Subarticle 1086-1(A). Plastic lenses shall have an abrasion resistant coating.

(1) Potted Markers

Potted marker shells shall be made of molded methyl methacrylate conforming to Federal Specification L-P-380C, Type I, Class - 3. Filling material shall be an inert thermosetting compound selected for strength, resilience, and adhesion adequate to meet physical requirements of the Specifications. Sand or other inert granulars shall be embedded in the surface of the inert thermosetting compound and filler material prior to its curing to provide a surface, which will readily bond to the adhesive.

(2) Injection-molded Markers

Injection-molded markers shall consist of polymer materials selected for strength and resilience adequate to meet the physical requirements of the Specifications. The bottom surface of the marker shall contain grooves or nonsmooth structure designed to increase bonding with the adhesive.

(B) Optical Requirements

All optical performance for permanent raised pavement markers shall conform to ASTM 4280-04.

(C) Physical Properties

All physical properties for permanent raised pavement markers shall conform to ASTM 4280-04.

(D) Hot Bitumen Adhesives

Use Hot Bitumen adhesive for mounting the pavement markers to the pavement. The Hot Bitumen adhesive shall meet the requirements of Article 1081-7. Other adhesives such as epoxy or cold bituminous adhesive pads are will not be acceptable.

(E) Material Certification

Furnish a Type 2 Certification in accordance with Article 106-3 for all raised pavement markers prior to use.

1086-3 SNOWPLOWABLE PAVEMENT MARKERS

(A) General

(1) Use snowplowable pavement markers that have been evaluated by NTPEP. The snowplowable pavement marker shall consist of a cast iron housing with one or more glass or plastic face lens type reflective lenses to provide the required color designation. Shape the casting to deflect a snowplow blade upward in both directions without being damaged. Incorporate into the casting two parallel keels and a connecting web designed to fit into slots cut into the road surface. Plastic lens faces shall utilize an abrasion resistant coating.

(2) Use recycled snowplowable pavement whichmarkers that meet all the requirements of new snowplowable pavement markers except the requirement of Subarticle 1086-3(B)(1). Recycled snowplowable pavement markers with minimal variation in dimensions are acceptable only when the reflector fits in the casting of the recycled snowplowable pavement marker as originally designed.

(B) Castings

(1) Dimensions

The dimension and slope and minimum area of reflecting surface shall conform to dimensions as shown in the plans.

Minimum Area of Each Reflecting Surface = 1.44 in^2

(2) Materials

Nodular iron, meeting the requirements of ASTM A536.

(3) Surface

The surface of the keel and web shall be free of scale, dirt, rust, oil, grease or any other contaminant which might reduce its bond to the epoxy adhesive.

(4) Identification

Mark the casting with the manufacturer's name and model number of marker.

(C) Reflectors

(1) General

Laminate the reflector to an elastomeric pad and attach with adhesive to the casting.

Thickness of Elastomeric Pad = 0.04"

(2) Reflector Type

One-direction, one color (crystal)
Bidirectional, one color (yellow and yellow)
Bidirectional, two colors (red and crystal)
Bidirectional, two colors (red and yellow)

All pavement marker reflective lenses shall be in close conformance with the Federal Standard No. 595 colors as listed below when viewed during night situations.

Crystal:	Color No. 17886 (White)
Yellow:	Color No. 13538
Red:	Color No. 11302

(3) Reflector Optical Requirements

(a) Definitions

Horizontal entrance angle means the angle in the horizontal plane between the direction of incident light and the normal to the leading edge of the marker.

Observation angle means the angle, at the reflector, between observer's line of sight and the direction of the light incident on the reflector.

Specific intensity (S.I.) means candlepower of the returned light at the chosen observation and entrance angles for each foot candle of illumination at the reflector.

S.I. = RL x (D x D) IL
S.I. = Specific Intensity
RL = Reflected Light
IL = Incident Light
D = Test Distance

(b) Optical Performance

Test the reflector for specific intensity as described below:

Form a 1" diameter flat pad using #3 coarse steel wool per Federal Specification FF-W-1825. Place the steel wool pad on the reflector lens. Apply a load of 50 lbs. and rub the entire lens surface 100 times. (NOTE: Do not abrade the red lens of the Type 3 and Type 4 bi-directional units.)

Locate the reflector to be tested with the center of the reflecting face at a distance of 5 ft from a uniformly bright light source having an effective diameter of 0.2".

The photocell must be an angular ring 0.37" I.D. x 0.47" O.D. Shield it to eliminate stray light. The distance from light source center to the center of the photoactive area shall be 0.2". If a test distance of other than 5 ft is used, modify the source and receiver in the same proportion as the test distance.

After abrading the lens surface using the above steel wool abrasion procedure, the specific intensity of each crystal reflecting surface at 0.2 degrees observation angle must not be less than the following when the incident light is parallel to the base of the reflector.

MINIMUM SPECIFIC INTENSITY
(candle/footcandle/unit marker)

Horizontal-Entrance-Angle

Color	0 degrees	20 degrees
Crystal	3.00	1.20
Yellow	1.80	0.72
Red	0.75	0.30

(A) Optical Performance

All optical performance for snowplowable pavement markers shall conform to ASTM 4383-05.

(B) Physical Properties:

All physical properties for snowplowable pavement markers shall conform to ASTM 4383-05.

(C) Epoxy Adhesive

The epoxy adhesive shall meet the requirements of Section 1081.

Mix the Epoxy adhesive rapidly by a two component type automatic metering, mixing and extrusion apparatus.

(D) Material Certification:

Furnish a Type 2 Certification in accordance with Article 106-3 for all raised snowplowable markers prior to use.

SECTION 1087
PAVEMENT MARKINGS

1087-1 GENERAL

Yellow and white pavement markings shall be retroreflective. Black pavement markings shall be matte, non-retroreflective.

The material manufacturer has the option of formulating the pavement marking material according to his own specifications, however, the manufacturer shall meet all the minimum requirements specified herein.

All pavement marking materials, pigments, beads, and resins shall be free from all skins, dirt, and foreign objects.

Use pavement marking materials capable of being fabricated into pavement markings of specified dimensions and adhering to asphalt and portland cement concrete pavements when applied in accordance with their manufacturer's recommendation.

Pavement marking materials upon heating shall not exude fumes, which are toxic, or injurious to persons or property.

Homogeneously mix all pavement marking materials.

1087-2 COMPOSITION

(A) Paint Composition

Pavement marking paint shall be a ready mixed type paint product conforming to U.S. Federal Specification Number (FP96-Section 718.14) with spraying consistency suitable for use as a retroreflective pavement marking. Glass beads are dropped by suitable pressurized means into the wet paint as it is applied to the pavement.

(B) Removable Tape Composition

Removable tape pavement marking shall be composed of materials as specified by their manufacturer.

Use removable tape markings capable of conforming to pavement contours, breaks, faults, etc. through the action of traffic at normal pavement temperatures. The tape shall have resealing characteristics such that it is capable of fusing with itself and previously applied marking tape of the same composition under normal conditions of use. The removable tape markings shall be patchable.

Use removable tape markings capable of adhering to the pavement by means of a pressure-sensitive pre-coated adhesive or as directed by the manufacturer.

(C) Thermoplastic Composition

Use Thermoplastic Alkyd/Maleic pavement markings composed of the following materials:

COMPONENT	BY WEIGHT
Alkyd/Maleic Binder	18.0% Min
Glass Beads (Premixed)	30.0% Min
Titanium Dioxide Pigment (ASTM D476 Type 2)	10.0% Min.
Yellow Pigment (For Yellow Marking Only) Silica Encapsulated Lead Chromate Pigment	4.0% Min.

Use white thermoplastic that does not contain anatase titanium dioxide pigment.

Provide Yellow Thermoplastic that contains only heat resistant silica encapsulated lead chromate pigment. The lead chromate pigment shall contain a minimum of 60% lead chromate.

Calcium carbonate and inert fillers may be as opted by the manufacturer, providing all other qualifications are met.

The total silica content used in the formulation of the thermoplastic shall be the premixed glass beads. Uniformly disperse the pigment, beads, and filler in the binder.

The Alkyd/maleic binder shall consist of a mixture of synthetic resins (at least one synthetic resin shall be solid at room temperature) and a high boiling point plasticizers. At least one-half of the binder composition shall be 100% maleic-modified glycerol of resin and be no less than 15% by weight of the entire material formulation. The binder shall contain no petroleum hydrocarbon resins. Use resins/rosins that are maleic-modified glycerol esters.

The thermoplastic material shall be free of contaminates and be homogeneously dry-blended or hot mixed from 100% virgin stock using no reprocessed materials, (excluding the requirement to use reprocessed glass).

The thermoplastic material shall not deteriorate or discolor when held at the application temperatures for periods of time of up to 4 hours or upon repeated reheating (a minimum of 4 times).

The color, viscosity, and chemical properties versus temperature characteristics of the thermoplastic material shall remain constant for up to 4 hours at the application temperature and be the same from batch to batch.

The thermoplastic material shall be readily applicable at temperatures between 400°F & 440°F from the approved equipment to produce lines and symbols of the required

above the pavement thickness.

(D) Cold Applied Plastic Composition

Cold applied plastic pavement marking shall be composed of the following materials:

COMPONENT	BY WEIGHT
Resins and Plasticizers	20% Min.
Pigments	30% Min.
Graded Glass Beads	33% Min.

The cold applied plastic pavement marking shall consist of a mixture of high quality polymeric materials, pigments, and glass beads distributed throughout its base cross-sectional area, with a reflective layer of beads bonded to the top surface.

The cold applied plastic markings shall adhere to the pavement by means of a pressure-sensitive pre-coated adhesive.

The cold applied plastic shall conform to pavement contours, breaks, faults, etc. through the action of traffic at normal pavement temperatures. The film shall have resealing characteristics such that it is capable of fusing with itself and previously applied marking tape of the same composition under normal conditions of use. The cold applied plastic pavement marking shall be patchable.

1087-3 COLOR

All pavement markings, without drop-on beads, shall visually match the color chips that correspond to the Federal Standard Number 595b for the following colors:

WHITE: (Color 17886)
YELLOW: (Color 13538)
BLACK: (Color 37038)

1087-4 GLASS BEADS

(A) Composition

The silica content of the glass beads shall be at least 60 percent.

Manufacture the beads from 100% recycled non-pigmented glass from a composition designed to be highly resistant to traffic wear and to the effects of weathering. All standard intermix and drop on glass beads shall be manufactured using 100% North American recycled glass cullet.

This requirement will not apply for tape.

(B) Physical Characteristics

The glass beads shall be colorless, clean, transparent and free from milkiness, excessive air bubbles, skins and foreign objects. The glass beads shall have a minimum refractive index of 1.50 when tested by the liquid immersion method (see ASTM D-1214 Becke Line Method or equal) at 77°F ±9°F be spherical in shape, be essentially free of sharp angular particles, and particles showing surface scarring and scratching.

(C) Gradation & Roundness

Use glass beads in all pavement markings with a minimum of 80% true spheres when tested according to ASTM D-1155. All Drop-On Glass Beads shall test in accordance with ASTM D-1214. All Drop-On Glass Beads used on Polyurea, Thermoplastic, Paint, and Heated-In-Heated-In-Place thermoplastic shall meet the following gradation requirements:

U.S. Standard Sieve Size	MINIMUM	MAXIMUM
Passing #20	100%	--
Retained on #30	5%	10%
Retained on #50	40%	80%
Retained on #80	15%	40%
Passing #80	0%	5%
Retained on #200	0%	5%

All Glass Beads Premixed in Thermoplastic, Heated-In-Place Thermoplastic, Cold Applied Plastic and Removable Tape shall meet AASHTO M-247 type I.

(D) Chemical Resistance

Conduct the following chemical resistance test on all glass beads:

Place 3 to 5 gram portions of the same glass bead batch to be tested in three separate Pyrex-glass beakers or three porcelain dishes. Cover one sample with distilled water, cover the second sample with 3N solution of Sulfuric Acid, and cover the third sample with 50% solution of sodium sulfides. After one hour of immersion, examine the glass bead samples microscopically for evidence of darkening and/or frosting. All 3 samples shall show no evidence of darkening and/or frosting.

(E) Moisture Resistance

Conduct the following moisture resistance test on Drop-on glass beads:

Place a 2 lb. minimum sample of glass beads in a clean, washed cotton bag with a thread count of 50 warp, 50 woof. Immerse the bag containing the sample in a container of water for thirty seconds or until the water covers the spheres, whichever is longer. Remove the bag from water and force excess water from the sample by squeezing the bag. Suspend the bag and allow to drain for two hours at room temperature 70°F-72°F. Then mix the sample in the bag by shaking thoroughly. Transfer the sample slowly to a clean dry glass funnel having a stem of 4" in length with 1/4" inside diameter. The entire sample shall flow freely through the funnel without stoppage. When first introduced in the funnel, if the spheres clog, it is permissible to lightly tap the funnel to initiate the flow.

1087-5 PACKAGING FOR SHIPMENT

Deliver all pavement marking and glass bead materials to the project in suitable containers packaged by the manufacturer. Clearly and adequately mark each material container to indicate the material, color, date of manufacture, process, batch or lot number, manufacturer's name and location, temperature application range, shelf life, and include the material safety data sheets (MSDS).

Thermoplastic pavement marking materials shall be in block or granular form packaged in either suitable corrugated containers or thermal degradable plastic bags to which it will not adhere during shipment or storage.

Package glass beads in moisture resistant bags.

1087-6 STORAGE LIFE

All pavement marking materials shall meet the requirements of this Specification for a period of one year from the date of shipment from the manufacturer to the Contractor, or the project. Replace any pavement marking materials not meeting the requirements of these Specifications.

1087-7 TESTS TO BE PERFORMED

When Independent Test Laboratory tests are required, perform them on samples taken by an agency certified by the Department from the same process, batch, or lot number as the material shipped to the project. The test reports shall contain the lot number. Independent Test Laboratories shall be approved by the Department.

Perform the following tests on pavement marking materials unless prescribed otherwise by the Engineer:

(A) Thermoplastic Pavement Marking Material

(1) Composition

(a)	% Binder	ASTM D4797
(b)	% Titanium Dioxide Pigment	ASTM D3720 or D4764
(c)	% Lead Chromate Pigment	D4797

(d) % Glass Beads ASTM D4797

(Except ash a 100 gram sample rather than a 10 gram sample to allow for testing of gradation and percent of rounds. Provide the results of sieve analysis and % rounds)

(2) Flash Point: ASTM D92 COC

The thermoplastic shall have a flashpoint of no less than 500°F.

(3) Requirements:

The thermoplastic material after heating for 240±5 minutes at 425±3°F and cooled to 77±3°F shall meet the following:

(a) Color:

White: Daylight reflectance 2° Standard observer and CIE illuminant

Using XYZ scale D65/10° 80 percent minimum.

ASTM E1349

Yellowness Index - The white thermoplastic shall not exceed a yellowness index of 0.12.

Yellow: Daylight reflectance at 2° Standard observer and CIE illuminant

Using XYZ scale D65/10° 45 Percent minimum =Y.

ASTM E 1349

(b) Bond Strength: ASTM D4796 (200 PSI minimum)

(c) Cracking Resistance at Low Temperatures-After applying a 4", 125 mil draw-down to concrete blocks and cooling to 15±3°F, the material shall show no cracks at an observation distance of 12".

(d) Specific Gravity: ASTM D792 1.95-2.20

(e) Softening Point: ASTM D36 215±15°F

(f) Drying Time: AASHTO T250 When applied at a thickness of 125 mils, the material shall set to bear traffic in no more than 2 minutes when air and substrate temperature is 50°F±3°F (and no more than 10 minutes when the air and substrate temperature is 90°F±3°F when applied at temperature of 412.5±12.5°F.

(g) Alkyd Binder Determination: The thermoplastic material shall immediately dissolve in diacetone alcohol. Slow dissolution is evidence of the presence of hydrocarbon binder components.

(h) Indentation Resistance: ASTM D2240 The Shore Type A2 Durometer with a 4.41 lb. load applied shall be between 40 and 75 units after 15 seconds at 115°F.

1087-8 MATERIAL CERTIFICATION

Furnish the following pavement marking material certifications in accordance with Article 106-3:

Glass Beads (for paint) - Type 3 Material Certification

Glass Beads (for thermoplastic and Polyurea) - Type 3 Material Certification and Type 4 Material Certification

Paint: Type 3 Material Certification

Removable Tape: Type 3 Material Certification

Thermoplastic: Type 3 Material Certification and Type 4 Material Certification

Thermoplastic and Polyurea: Type 3 Material Certification and Type 4 Material Certification

Cold Applied Plastic: Type 2 Material Certification and Type 3 Material Certification

SECTION 1088
DELINEATORS

1088-1 REFLECTIVE UNIT REQUIREMENTS FOR DELINEATORS

(A) Definition

Refer to ASTM D-4956

Entrance Angle means the angle at the reflector between direction of light incident on it and direction of reflector axis.

Observation Angle means the angle at the reflector between observer's line of sight and direction of light incident on the reflector.

Specific Intensity means the candlepower returned at the chosen observation angle by a reflector for each footcandle of illumination at the reflector.

(B) Reflective Elements

(1) Prismatic Plastic Type

(a) General

The reflector shall consist of an acrylic plastic prismatic reflector hermetically sealed to an acrylic plastic back.

The reflector shall consist of a clear and transparent face, herein referred to as a lens, with an acrylic plastic back fused to the lens under heat pressure around the entire perimeter of the lens. Where a central mounting hole is required, permanently seal the unit against dust, water, and water vapor.

The lens shall consist of a smooth front surface free from projections or indentations, other than a central mounting hole and identification

markings. Mold the manufacturer's trademark legibly into the face of the lens.

(b) Specific Intensity

Refer to ASTM D-4956

The specific intensity of each prismatic plastic type reflector shall be equal to, or exceed, the following minimum values with measurements made with reflectors spinning. Failure to meet the specific intensity minimum will constitute failure of the lot.

Observation Angle(Degrees)	Entrance Angle (Degrees)	Specific Intensity (Candlepower per Footcandle)		
		Crystal	Yellow	Red
0.1°	0°	119	71	29
0.1°	15°	119	28	--
0.1°	20°	47	28	11
0.1°	35°	50	30	--

Optical Testing Procedure

Locate the prismatic plastic type reflector to be tested at a distance of 100 feet from a single light source having an effective diameter of 2" operate the light source at approximately normal efficiency. Measure the return light from the reflector by means of a photoelectric photometer having a minimum sensitivity of 1 x 10 foot candles per mm scale division. The photometer shall have a receiver aperture of 0.5" diameter, shielded to eliminate stray light. The distance from light source center to aperture center shall be 2.1" for 0.1 observation angle. During testing, spin the reflectors so as to average the orientation effect.

If a test distance other than 100 feet is used, modify the source and aperture dimensions, and the distance between source and aperture, in the same proportion as the test distance.

(c) Durability

Seal Test

Use the following test to determine if a reflector is adequately sealed against dust and water:

Submerge 50 samples in water at room temperature. Subject the submerged samples to a vacuum of 5" gauge for 5 minutes. Restore atmospheric pressure and leave the samples submerged for 5 minutes, then examine the samples for water intake. Evidence of any water is considered a failure. Failure of more than 2% of the number tested will be cause for rejection.

Heat Resistance Test:

Test three reflectors for 4 hours in a circulating air oven at 175°+5°F. Place the test specimens in a horizontal position on a grid or perforated shelf, permitting free air circulation. At the conclusion of the test, remove the samples from the oven and permit them to cool in air to room temperature. The samples, after exposure to heat, shall show no change in shape and general appearance when compared with unexposed control standards. Any failures will be cause for rejection.

(2) High Performance Sheeting Type

The reflective sheeting shall be Type III high intensity (encapsulated lens) retroreflective sheeting or Type IV high intensity (microprismatic) retroreflective sheeting which conforms to the requirements of Section 1093.

1088-2 GUARDRAIL AND BARRIER DELINEATORS

(A) Brackets and Casings for Delineators

Make brackets for guardrail and barrier delineators out of 12 gauge galvanized steel, 0.063" thick aluminum alloy, or .080" thick polycarbonate. Use molded plastic type guardrail and barrier delineators that consist of a plastic casing and a reflective element.

(B) Reflective Element Requirements

The reflective element shall meet the requirements of Article 1088-1. In addition, guardrail delineators and side mounted barrier delineators shall have a minimum reflective area of 7 square inches. Top mounted barrier delineators shall have a minimum reflective area of 28 square inches.

(C) Material Certification

Furnish a Type 2 Material Certification in accordance with Article 106-3 for all guardrail and barrier (permanent) delineators and a Type 7 for all guardrail and barrier delineators (temporary) prior to use.

(D) Approval

All materials are subject to the approval of the Engineer.

1088-3 GUARDRAIL END DELINEATION

(A) General

Use guardrail end delineation that is adhesive coated yellow reflective sheeting applied with a pressure sensitive adhesive backing.

(B) Reflective Sheeting Requirements

Use Type III high intensity (encapsulated lens) or Type IV high intensity (microprismatic) yellow retroreflective sheeting which conforms to the requirements of Section 1093 for all guardrail end delineation. In addition, guardrail end

delineation shall have a minimum reflective area of 2 square feet for curved end sections or cover the entire portion of square end sections. See *Roadway Standard Drawings*.

(C) Material Certification

Furnish a Type 2 Material Certification in accordance with Article 106-3 for all guardrail end delineation prior to use.

(D) Approval

All materials are subject to the approval of the Engineer.

1088-4 BLANK

1088-5 OBJECT MARKERS

(A) General

Use 7 ft. galvanized steel U-shaped channel posts as supports for delineators that are fabricated from steel conforming to the requirements of ASTM A36 or ASTM A409. Use 7 foot posts, which weigh a minimum of 1.12 lbs per linear foot after fabrication and application of protective finish. Punch or drill all posts with 3/8" diameter holes on the centerline, spaced on 1" centers, starting 1" from the top and extending a minimum of 24" down the posts. Make sure that the holes are clean and the posts are free of burrs. Hot dip galvanize the posts after fabrication for the full length and total area in accordance with ASTM A123.

(B) Reflectors

Use 3" diameter prismatic plastic reflectors on object markers that meet the requirements of Subarticle 1088-1(B)(1).

(C) Reflective Sheeting Requirements

Use reflective Type III high intensity or Type IV high intensity (microprismatic) retroreflective sheeting on object markers that meet the requirements of Article 1093.

(D) Panel Requirements

Use panels that meet the requirements of Article 1092-1.

(E) Fasteners

Use fasteners that meet the requirements of Article 1092-1.

(F) Material Certification

Furnish a Type 5 Certification for sheeting, a Type 2 Certification for delineators, and a Type 1 Certification for U-channel posts in accordance with Article 106-3 prior to use.

(G) Approval

All materials are subject to the approval of the Engineer.

1088-7 TUBULAR MARKERS

(A) General

Provide tubular markers that are made of ultraviolet stabilized plastic impact resistant material and have been evaluated by NTPEP. Provide orange, yellow, white, and gray tubular markers as shown in the plans.

Provide tubular markers that are flexible or have a flexible joint at the base, such that it will return to its original shape and position if struck by a 5,000 Lb. vehicle at a velocity of 55 MPH. When struck the tubular markers shall not permanently distort to a degree that would prevent reuse.

Use tubular markers that are circular in shape and have a minimum height of 36" with a broadened base. Use tubular markers that have a minimum height of 42" on roadways with posted speed limits greater than 50 MPH.

Design tubular markers that have white retroreflective collars or as shown in the contract.

Where retroreflective collars are required, provide Type III high intensity (encapsulated lens) retroreflective sheeting or better that meets the requirements of Section 1093. Use retroreflective sheeting with a minimum width of 4" applied 360 degrees around the tubular marker.

(B) Material Certification

Furnish a Type 3 Material Certification in accordance with Article 106-3 for all new tubular markers and retroreflective collars and a Type 7 material certification for all used tubular markers and retroreflective collars prior to use.

(C) Approval

All materials are subject to the approval of the Engineer.

1088-8 FLEXIBLE DELINEATOR

(A) General

Provide Flexible delineators that have been evaluated by NTPEP.

(B) Retroreflective Sheeting

Use retroreflective sheeting that is a minimum of 16 square inches in area, with a minimum width of 3". The reflective sheeting shall be Type III high intensity (encapsulated lens) retroreflective sheeting or better and shall conform to the requirements of Section 1093.

Use retroreflective sheeting which is yellow, red, or crystal, as shown in the plans. Attach the retroreflective sheeting on the front and back of the delineator post as required by the contract.

(C) Post

Design a delineator post that is flexible and made of recycled material. Provide a delineator post that is resistant to impact, ultraviolet light, ozone, hydrocarbons, and stiffening with age.

Provide a post that is not seriously affected by exhaust fumes, asphalt or road oils, dirt, vegetation, soil, deicing salts, or any other types of air contamination or materials likely to be encountered. Upon weathering, the post shall not exhibit serious discoloration, checking or cracking, peeling or blistering, swelling, shrinking or distortion, or any other detrimental effects. Weathering shall not cause appreciable strength or flexibility loss.

Design a post with a smooth surface that is free from irregularities or defects. The surface of the post shall not soil excessively. If soiling does occur, it shall be easily cleaned using detergent and water, or solvent.

Use posts that have a convex shaped cross-section. The cord distance for the cross-section shall be from 3.5" to 4.5" in length.

Design a post such that it can maintain straightness throughout its entire life. Straight is defined as no point along its length any more than 1" away from a perfectly straight edge placed longitudinally along any side of the post.

Provide a post in which both sides of the top of the post accepts, and holds securely, retroreflectorized sheeting.

Design posts that are gray in color.

(D) Base Support

Provide a base support that is hot rolled rail steel or new billet steel meeting the physical requirements of ASTM A499, the chemical requirements of ASTM A1 and the requirements of Article 1088-5.

Use a base support that is a uniform flanged U-channel post with a nominal weight of 3 lbs/ft before holes are punched. Use base support posts that are 18" in length and have sufficient number of 3/8" diameter holes on 1" centers to facilitate attachment of the flexible post.

(E) Anchoring

Design a delineator post for a permanent installation to resist overturning, twisting, and displacement from wind and impact forces.

(F) Temperature

Design flexible delineators that do not bend, warp, or distort and remain straight, when stored or installed at temperatures up to + 120^{o}F. Design All components of the flexible delineator, post, and reflective sheeting to remain stable and remain fully functional within a temperature range of -20^{o}F to + 120^{o}F.

(G) Impact Resistance, Wind Resistance

Design Flexible delineators that meet the Impact and wind resistance of the current evaluation criteria of the National Transportation Product Evaluation Program.

(H) Product Identification

Provide flexible delineator post that are permanently identified, on the rear side, with the manufacturer's name and the month and year of fabrication in order to provide

a tracking method for ongoing outdoor evaluation, and specification quality control. The letters shall be a minimum of 1/4" in height and permanently affixed to the rear of the marker.

(I) Material Certification

Furnish a Type 2 and Type 3 Certification in accordance with Article 106-3 for all flexible delineators prior to use.

(J) Approval

All materials are subject to the approval of the Engineer.

SECTION 1089
TRAFFIC CONTROL

1089-1 WORK ZONE SIGNS

(A) General

Rigid sign retroreflective sheeting requirements for Types VII, VIII and IX prismatic fluorescent orange shall conform to Section 1093. Cover the entire sign face of the sign substrate with Department approved Type VII, VIII or IX prismatic fluorescent orange reflective sheeting. No bubbles or wrinkles will be permitted in the material.

Roll-up sign retroreflective requirements shall conform to section 1093.

(1) Work Zones Signs (Stationary)

Use Type VII, VIII or IX (prismatic) fluorescent orange retroreflective sheeting that meets the following reflective requirements in Section 1093 respectively. Use approved composite or aluminum for sign backing. Signs and sign supports shall meet NCHRP 350 requirements for Breakaway Devices.

(2) Work Zones Signs (Barricade Mounted)

Use approved composite or roll-up signs for barricade mounted sign substrates. Approved composite barricade mounted warning signs (black on orange) shall be Type VII, VIII or IX sheeting that meets the retroreflective requirements of Section 1093. Sign and barricade assembly shall meet or exceed the requirements of NCHRP 350 for Work Zone Category II Devices.

(3) Work Zones Signs (Portable)

Use approved composite or roll-up sign substrates on portable sign stands.

Composite - Use Type VII, VIII or IX (prismatic) fluorescent orange retroreflective sheeting that meets the following reflective requirements in Section 1093. Signs and sign supports shall meet NCHRP 350 requirements for Breakaway Devices.

Roll-up Signs - Use fluorescent orange retroreflective roll-up signs that meet the following reflective requirements of Section 1093.

Use roll up signs that have a minimum 3/16" x 1 1/4" horizontal rib and 38" x 1 1/4" vertical rib and has been crash test to meet NCHRP 350 requirements and Traffic Control qualified by the Work Zone Traffic Control Unit.

(B) Material Certification

Furnish a Type 3 Material Certification in accordance with Article 106-3 for all new reflective sheeting and a Type 7 Material Certification for all used reflective sheeting prior to use.

(C) Approval

All materials are subject to the approval of the Engineer.

(D) Warranty

Warranty requirements for rigid sign retroreflective sheeting Types VII, VIII and IX are described in Section 1093-9 (F).

Roll-up fluorescent orange retroreflective signs will maintain 80% of its retroflectivity as described in Section 1093 for years 1 – 2 and 50% for year 3.

Rigid and Rollup Fluorescent orange signs will maintain a Fluorescence Luminance Factor (Y_F)* of 13% for 3 years.

*Fluorescence Testing Method is described in ASTM E2301 Test Methods for Fluorescent Retro reflective Sheeting.

Rigid and Roll up fluorescent orange signs shall maintain a total Luminance Factor (Y) of 25 for 3 years and conform to the requirements of section 1093 when measured in accordance with ASTM D4956.

1089-2 WORK ZONE SIGNS SUPPORTS

(A) General

Type of Supports

(1) Work Zone Signs (Stationary)

Provide Work Zone Sign Supports for Work Zone Signs (Stationary) that are sturdy, durable and crashworthy. Work Zone Signs (Stationary) and their supports shall meet appropriate NCHRP 350 crash criteria for category II work zone devices.

Use 3-Lb Steel U-Channel Post or 4"x 4" wood post for all Work Zone Signs greater than 16 square feet. Three lb. Steel U-Channel posts shall meet the requirements in Section 1049-1(B), may be galvanized steel, or may be painted green by the post manufacturer. Square steel tubing posts having equivalent strength of the 3-Lb. Steel U-Channel Post are also acceptable for use.

(2) Work Zone Signs (Portable)

Use Work Zone Signs and Portable Work Zone Sign Stands that are sturdy, durable and crashworthy.

(B) Material Certification

Provide portable work zone signs and stands that are listed on the Department's approved product list or accepted as traffic qualified by the Traffic Control Section. For more information on the Traffic-Qualification process, contact the Traffic Control Section.

Furnish a Type 3 Material Certification in accordance with Article 106-3 for all new Work Zone Sign (Stationary) posts and a Type 7 Material Certification for all used Work Zone Sign (Stationary) posts prior to use.

Furnish a Type 3 Material Certification in accordance with Article 106-3 for all new portable Work Zone Sign Stand Assemblies and a Type 7 Material Certification for all used portable Work Zone Sign Stand Assemblies prior to use.

(C) Approval

All materials are subject to the approval of the Engineer.

1089-3 BARRICADES

(A) General

Construct barricades out of perforated square steel tubing, angle iron or other Department approved materials that meet or exceed the requirements of NCHRP 350 crash criteria for category II work zone devices..

Use barricade rails constructed of approved composite, hollow/corrugated extruded rigid polyolefin, high density polyethylene or other Department approved material that have a smooth face and alternating orange and white retroreflective stripes that slope at an angle of 45 degrees. Barricade rails shall meet or exceed the requirements of NCHRP 350 crash criteria for category II work zone devices.

(B) Supports

Support barricade rails in a manner that will allow them to be seen by the motorist and provide a stable support not easily blown over by the wind or traffic.

(C) Reflective Sheeting

Use Type VII, VIII or IX retroreflective sheeting that meets the requirements of Section 1093. Flame treat rails prior to applying the sheeting if required by the sign sheeting manufacturer. Apply the reflective sheeting with a pressure sensitive adhesive to both sides of the rails.

Use the same color sheeting on each rail of any individual barricade.

(D) Material Certification

Furnish a Type 3 Material Certification in accordance with Article 106-3 for all new barricades and a Type 7 Material Certification for all used barricades prior to use.

(E) Approval

All materials are subject to the approval of the Engineer.

1089-4 CONES

(A) General

Use cones made of ultraviolet stabilized plastic impact resistant material meeting the requirements of the MUTCD and this article. Orange will be the predominant color on cones.

Use cones conical in shape, with a minimum height of 28" or 36" and a minimum base dimension of 14 1/2" as shown in the plans. The 28" and 36" cones (excluding ballast) shall have a minimum weight of 7 pounds and 10 pounds respectively. When in an upright position, have the cones display the same dimensions regardless of their orientation to oncoming traffic.

(B) Ballast

Provide wind resistant cones that do not blow over under normal roadway conditions, including high speed truck traffic in close proximity to the cones when properly ballasted. Provide cones that do not permanently distort to a degree that would prevent reuse when struck.

Achieve ballasting of the cones by using any of the following methods:

(1) Cones with bases that may be filled with ballast,

(2) Doubling the cones or using heavier weighted cones,

(3) Cones with special weighted bases, or weights such as sandbag rings that can be dropped over the cones and onto the base to provide increased stability.

Seventy percent of the weight of the cone shall be in the base. These added weights shall not present a hazard if the devices are inadvertently struck.

(C) Retroreflective Collars

Where retroreflective collars are required, provide Type VI flexible vinyl high intensity (encapsulated lens) retroreflective sheeting or better for these collars which meets the requirements of Section 1093. Use 2 retroreflective collars, the top one is 6" wide and the bottom one is 4" wide; see *Roadway Standard Drawings*.

(D) Material Certification

Furnish a Type 3 Material Certification in accordance with Article 106-3 for all new cones and cone collars and a Type 7 Material Certification for all used cones and retroreflective collars prior to use.

(E) Approval

All materials are subject to the approval of the Engineer.

1089-5 CHANNELIZING DEVICES

(A) Drums

(1) General

Provide drums composed of a body, reflective stripes, and ballast that have been evaluated by NTPEP.

(2) Body

Provide a drum made of orange, impact resistant, ultraviolet plastic material capable of maintaining its integrity upon impact throughout a temperature range of -20°F to 125°F. When struck, the drum shall not permanently distort to a degree that would prevent reuse, nor roll excessively after impact. Design the drum to prevent water from accumulating and freezing in the top or bottom.

Provide a drum that is cylindrical in shape with the following dimensions; a minimum height of 36", a minimum top outer diameter of 18 " a bottom outer diameter of 21 to 24", and a weight of 12 to 15 pounds. The top outer diameter shall not exceed the bottom outside diameter. Provide closed tops on drums to prevent accumulation of debris.

(3) Retroreflective Stripes

Provide a minimum of three orange and two white alternating horizontal circumferential stripes. Use a 6 to 8" wide band of Type I Engineer Grade (enclosed lens) retroreflective sheeting or better that meets the requirements of Section 1093 for each band. Do not exceed 2" for any non-reflective spaces between orange and white stripes. Do not place stripes over any protruding corrugation areas. No damage to the reflective sheeting should result from stacking and unstacking the drums, or vehicle impact.

(4) Ballast

Ballast drums using the sandbag ballast method, the tire sidewall ballast method, or by the preformed weighted base ballast method. When properly ballasted, the drums shall be wind resistant to the extent of withstanding wind created by traffic under normal roadway conditions, including high speed truck traffic in close proximity to the drums. Do not place ballast on top of the drum.

(a) Sandbag Ballast Method

Supply a sandbag with 50 pounds of sand with each drum. Place the sandbag inside the body on top of the detachable base. Upon impact the main body of the drum shall deform and become detached from the base, allowing vehicles to easily pass over the remaining base

(b) Tire Sidewall Ballast Method

Design the base of the drums to accommodate a maximum of two tire sidewalls that when combined will have a minimum weight of thirty pounds and a maximum weight of fifty pounds. Use the manufacturer's required tire sidewall ballast. Upon impact the main body of the drum shall deform and become detached from the tire sidewalls, allowing vehicles to easily pass over the tire sidewall ballasts.

(c) Preformed Weighted Base Ballast Method

Supply a preformed base specifically designed for the model drum. The weight of each drum's preformed base will be self-certified by the manufacturers. Each drum with preformed bases shall be approved by the Work Zone Traffic Control Unit. Upon impact, the main body of the drum shall deform and become detached from the base allowing vehicles to easily pass over the remaining base.

(5) Material Certification

Furnish a Type 3 Certification in accordance with Article 106-3 for all new drums and a Type 7 Material Certification for all used drums prior to use.

(6) Approval

All materials are subject to the approval of the Engineer.

(B) Skinny-Drums

(1) General

Provide skinny-drums composed of a body, reflective stripes, and ballast and have been evaluated by NTPEP.

(2) Body

Provide a skinny-drum made of orange, impact resistant, ultraviolet plastic material capable of maintaining its integrity upon impact throughout a temperature range of -20°F to 125°F. When struck, the skinny-drum shall not permanently distort to a degree that would prevent reuse, nor roll excessively after impact. Design the skinny-drum to prevent water from accumulating and freezing in the top or bottom.

Provide a skinny-drum that is cylindrical in shape with the following dimensions; a minimum height of 42", a minimum top outer diameter of 4" and a bottom outer diameter of 7.5". The top outer diameter shall not exceed the bottom outside diameter. Provide closed tops on drums to prevent accumulation of debris.

(3) Retroreflective Stripes

Provide a minimum of two orange and two white alternating circumferential stripes for each skinny-drum. Use a minimum 6" or better that meets the

requirements of Section 1093 for each band. Do not exceed 2" for any non-reflective spaces between orange and white stripes. Do not place stripes over any protruding corrugation areas. No damage to the reflective sheeting should result from stacking and unstacking the skinny-drums, or vehicle impact.

(4) Ballast

Ballast skinny-drums using a preformed base specifically designed for the model skinny-drum. Each base shall be a minimum of 15 pounds and circular or polygonal with equal sides. When properly ballasted, the skinny-drums shall be wind resistant to the extent of withstanding wind created by traffic under normal roadway conditions including high speed truck traffic in close proximity to the skinny-drums. Do not place ballast on top of the drum. Upon impact, the main body of the drum shall deform and become detached from the base allowing vehicles to easily pass over the remaining base.

(5) Material Certification

Furnish a Type 3 Certification in accordance with Article 106-3 for all new skinny-drums and a Type 7 Material Certification for all used skinny-drums prior to use.

(6) Approval

All materials are subject to the approval of the Engineer.

1089-6 FLASHING ARROW PANELS

(A) General

Provide a trailer mounted flashing arrow panel that meets or exceeds the physical and operational requirements of the MUTCD and which has been evaluated by NTPEP. The following specifications supplement those basic requirements. Provide a totally mobile complete unit capable of being located as traffic conditions demand.

Display Panel

The display housing shall meet the minimum size requirements of a Type C panel with a 15 or 25 lamp configuration.

The display housing shall have a hand-crank mechanism to allow raising and lowering the display with a locking device to ensure the display housing will remain secured in either position

The display housing will have a minimum height of 7 feet from the bottom of the sign to the ground when raised in the upright position.

The display housing assembly shall be of weather resistant construction.

The lamps shall be controlled to provide the following modes as a minimum;

Flashing Right or Left Arrow, Flashing Double Arrow, Caution Mode (4 outermost corner lamps).

(B) Power System

Provide a unit that is solar powered and supplemented with a battery backup system that includes a 110/120 VAC powered on-board charging system.

The unit shall also be capable of being powered by standard 110/120 VAC power source.

The batteries, when fully charged, shall be capable of powering the display for 20 continuous days with no solar power.

Store the battery bank and charging system in a lockable, weather and vandal resistant box.

(C) Controller

Provide an automatic brightness/dimming of the display and a manual override dimming switch.

The controller shall provide a battery-charge status indicator.

Mobile radio or any other radio transmissions shall not affect the controller.

Store the controller in a lockable, weather and vandal resistant box.

(D) Trailer

Finish all exterior metal surfaces with Federal orange enamel per Federal Standard 595a, color chip ID# 13538 or 12473 respectively. The trailer shall be able to support a 100 MPH wind load with the display fully extended.

The trailer shall be equipped with leveling jacks capable of stabilizing the unit in a horizontal position when located on slopes 6:1 or flatter.

The trailer shall be properly equipped in compliance with North Carolina Law governing motor vehicles.

Provide a minimum 4" wide strip of fluorescent orange retroreflective sheeting to the frame of the trailer. Apply the sheeting to all sides of the trailer. The sheeting shall meet the requirements of Section 1088-1. Drums may be supplemented around the unit in place of the sheeting.

(E) Reliability

Provide a sign unit that all components are rated to operate at temperatures ranging from -30°F to 165°F.

The sign manufacturer shall notify the Work zone Traffic Control Unit whenever modifications are made to their sign that was prequalified on the Approved Products List. The Work Zone Traffic Control Unit will review changes and per its discretion either make no change to the sign's status or remove the sign from the list until the sign can be reevaluated.

(F) Material Certification

Furnish a Type 3 Certification in accordance with Article 106-3 for all new changeable message signs, a Type 7 Material Certification for all used changeable message signs, and wind load certifications required in Section 1089-6(C) for all new and used changeable message signs prior to use.

(G) Approval

The sign shall be on the Work Zone Traffic Control Approved Products List before use on construction projects in North Carolina. A sign may be removed from the Approved Products List due to unsatisfactory field performance and shall not return to the list until the manufacturer identifies the reason for the failure and the problem has been corrected to the satisfaction of the Department.

The sign manufacturer shall notify the Department whenever modifications are made to their sign that was prequalified on the Approved Products List. The Department will review changes and per its discretion, either make no change to the sign's status on the Approved Products List or remove the sign from the list until the sign can be reevaluated.

1089-7 CHANGEABLE MESSAGE SIGNS

(A) General

Provide trailer mounted changeable message signs that meet or exceed the requirements of the MUTCD and have been evaluated by NTPEP.

Provide a totally mobile complete sign unit capable of being located as traffic conditions demand.

(B) Display Panel

Provide 3 lines of a programmable message with a minimum of eight characters per line and a character height at a minimum of 18".

The display characters will be composed of LED elements. The display panel may be of the following types- Full Matrix, Continuous Line Matrix, and Character Matrix.

Messages are to be automatically centered and proportionally spaced on each line of a Full Matrix and Continuous Line Matrix displays. Character Matrix displays shall display odd number character messages one character left of the centerline.

The display characters shall be protected with a polycarbonate lens that shall not decrease the daytime visibility of the sign.

The display panel shall have an electro-hydraulic system to allow raising and lowering the display with 360 degree rotation capability. A locking device(s) shall be provided to ensure the display will remain secure in the raised, lowered and rotated positions. The sign shall have the capability to be raised and rotated to its operating position by one person.

A manual backup mechanism for the raising and lowering the display panel shall be provided in the event the electro-hydraulic system fails.

The display panel assembly shall be of weather resistant construction

(C) Power System:

The unit shall be Solar powered and supplemented with a battery backup system which includes a 110/120 VAC powered on-board charging system.

The batteries, when fully charged, shall be capable of powering the display for 20 continuous days with no solar power. The unit shall be capable of being powered by standard 110/120 VAC power source.

Store the battery bank and charging system in a lockable, weather and vandal resistant box.

(D) Controller

The controller shall provide at a minimum; a keyboard, a display for message review and editing, a light source for nighttime operations, an event time clock and all other required controls for the operation of the display. Access to controller operations shall have the capability to be password protected.

The controller shall include the following capabilities; manually dimming the display, storing a minimum of 99 user generated messages, adjusting the flash rate of display and display phasing and monitoring battery-charge status.

Mobile radio or any other radio transmissions shall not affect the controller.

The controller shall be stored in a lockable, weather and vandal resistant box.

The controller shall be pre-programmed with messages shown below and stored in memory:

MAX SAFE SPEED 25 MPH	MAX SAFE SPEED 30 MPH
STOP AHEAD	YIELD AHEAD
MAX SAFE SPEED 35 MPH	MAX SAFE SPEED 40 MPH
MAX SAFE SPEED 45 MPH	MAX SAFE SPEED 50 MPH
ONE LANE BRIDGE	SURVEY CREW
MAX SAFE SPEED 55 MPH	DETOUR AHEAD
CAUTION DETOUR AHEAD	LANE CLOSED AHEAD
RIGHT LANE CLOSED	LEFT LANE CLOSED
CENTER LANE CLOSED	SINGLE LANE AHEAD
MERGE LEFT	MERGE RIGHT
KEEP LEFT	KEEP RIGHT
PASS LEFT	PASS RIGHT
USE LEFT LANE	USE RIGHT LANE
MERGE AHEAD	ROAD MACHINES AHEAD
ROAD WORK AHEAD	FLAGGER AHEAD
BUMP	DIP
STOP AHEAD	YIELD AHEAD
BE PREPARED TO STOP	SIGNAL AHEAD

SIGNAL NOT WORKING	DO NOT PASS
ONE LANE BRIDGE	SURVEY CREW
SHOULDER WORK	SOFT SHOULDER
PAVEMENT ENDS	LANE ENDS
ROAD CLOSED 1/4 MILE	ROAD CLOSED 1/2 MILE
ALL TRAFFIC EXIT LEFT	ALL TRAFFIC EXIT RIGHT
ROAD NARROWS	ROAD CLOSED AHEAD
RAMP CLOSED	REDUCE SPEED
ROAD PAVING AHEAD	ALL TRAFFIC MUST STOP
SLOW MOVING TRAFFIC	NIGHT WORK AHEAD
CAUTION FLAGGER AHEAD	RUNAWAY TRUCK RAMP
MEDIAN WORK AHEAD	
LEFT LANE NARROWS	RIGHT LANE NARROWS
* TEST PATTERN A	**TEST PATTERN B

* Test Pattern A is 1/2 of the LEDs/flip-discs/or combination on at a time

- ** Test Pattern B is for the remaining 1/2 of the LEDs/flip-discs/or combination on at a time.

(E) Trailer:

Finish all exterior metal surfaces with Federal orange enamel per Federal Standard 595a; color chip ID# 13538 or 12473 respectively except for the sign face assembly that shall be flat black.

Provide a minimum 4" wide strip of fluorescent orange retroreflective sheeting to the frame of the trailer. Apply the sheeting to all sides of the trailer. The sheeting shall meet the requirements of Section 1088-1. Drums may be supplemented around the unit in place of the sheeting.

The trailer shall be able to support a 100 MPH wind load with the display fully extended.

The trailer shall be equipped with leveling jacks capable of stabilizing the unit in a horizontal position when located on slopes 6:1 or flatter.

The trailer shall be properly equipped in compliance with North Carolina Law governing motor vehicles.

(F) Reliability

Provide a sign unit that all components are rated to operate at temperatures ranging from -30°F to 165°F.

(G) Material Certification

Furnish a Type 3 Certification in accordance with Article 106-3 for all new changeable message signs, a Type 7 Material Certification for all used changeable message signs, and wind load certifications required in Section 1089-6(C) for all new and used changeable message signs prior to use.

(H) Approval

The sign shall be on the Work Zone Traffic Control Approved Products List before use on construction projects in North Carolina. A sign may be removed from the Approved Products List due to unsatisfactory field performance and shall not return to the list until the manufacturer identifies the reason for the failure and the problem has been corrected to the satisfaction of the NCDOT.

The sign manufacturer shall notify NCDOT whenever modifications are made to their sign that was prequalified on the Approved Products List. The Department will review changes and per its discretion either make no change to the sign's status on the Approved Products List or removed the sign from the list until the sign can be reevaluated.

1089-8 TEMPORARY CRASH CUSHIONS.

(A) General

Provide temporary crash cushions that meet or exceed the requirements of NCHRP 350 for work zone Test Level 2 for work zones that have a posted speed limit of 45 mph or less. Provide temporary crash cushions that meet or exceed the requirements of or NCHRP 350 for work zone Test Level 3 devices for work zones that have a posted speed limit of 50 mph or greater. Provide temporary crash cushions that shall remain intact after a side impact, and without maintenance, be capable of sustaining additional side or head-on impacts.

Contain the temporary crash cushion debris resulting from impact within the structure of the temporary crash cushion.

Include in the temporary crash cushion package any required rear transition panels to connect the back of the temporary crash cushion to rigid or flexible barrier systems as well as any required portable base as recommended by the manufacturer of the temporary crash cushion, to connect the bottom of the temporary crash cushion to an unpaved surface.

(B) Retroreflective End Treatments

Provide a yellow nose wrap that visually matches the color chip that corresponds to the Federal Standard No. 595a for Yellow (Color No. 13538) for all temporary crash cushions.

The reflective end treatment shall meet the requirement for reflectivity in Article 1088-1 and Roadway Standard Drawings.

(C) Material Certification

Furnish a Type 3 Certification in accordance with Article 106-3 for all new temporary crash cushions and a Type 7 Material Certification for all used temporary crash cushions prior to use.

(D) Approval

Use temporary crash cushions that are on the Work Zone Traffic Control Approved Products List.

1089-9 TRUCK MOUNTED IMPACT ATTENUATORS

(A) General

Provide Truck Mounted Impact Attenuators that meet or exceed the requirements of NCHRP 350 Test Level II for work zones that have a posted speed limit of 45 mph or less. Provide Truck Mounted Impact Attenuators that meet or exceed the requirements of NCHRP 350 Test Level III for work zones that have a posted speed limit of 50 mph or greater.

Use trucks with gross vehicle tare weight as described in the NCHRP 350 crash test for the impact attenuator provided. Provide two axle flat bed type trucks with minimum gross vehicle tare weight of 5,000 pounds that may be ballasted with sections of portable concrete barrier attached to the bed of the truck with bolts or straps, or concrete poured into the bed of the truck and attached to the truck with bolts, or a continuous layer of asphalt placed in the bed of the truck and attached to the truck with bolts.

Mount the impact attenuator on a truck chassis to provide a uniform clearance, as required by the Truck Mounted Impact Attenuator's manufacturer, between the bottom of the shell and the roadway. Use a steel backup support assembly of sufficient size and strength to permit mounting on the chassis by means of brackets, as required by Truck Mounted Impact Attenuator's manufacturer.

Provide Truck Mounted Impact Attenuators equipped with cartridges that have a standard trailer lighting system, including brake lights, tail lights, and turn signals.

(B) Retroreflective End Treatment

The reflective end treatment shall meet the requirements of Article 1088-1 and Roadway Standard Drawings.

(C) Material Certification

Furnish a Type 3 Certification in accordance with Article 106-3 for all new truck mounted impact attenuators and a Type 7 Material Certification for all used truck mounted impact attenuators prior to use.

(D) Approval

Use only truck mounted impact attenuators that are on the Work Zone Traffic Control Approved Products List.

1089-12 FLAGGER

(A) Stop and Slow Paddle

(1) Reflective Sheeting

Use reflective sheeting with a smooth, sealed outer surface that will display the same color both day and night. Cover the entire sign face with Type VII, VIII or IX reflective sheeting. Reflective sheeting shall meet the requirements of Section 1093. The distance from the bottom of the sign to the ground shall be a minimum of 7 feet.

(2) Material Certification

Furnish a Type 3 Certification in accordance with Sections 106-3 for all new reflective sheeting used on flagger paddles and a Type 7 Material Certification for all used sheeting prior to use.

(3) Approval

All materials are subject to the approval of the Engineer.

(B) Vest

(1) Reflective Sheeting

Use reflective sheeting with sealed outer surface that will display the same color both day and night. Design the reflective sheeting similar to Department chevron vests. Reflective sheeting shall meet the requirements of Section 1093.

(2) Material Certification

Furnish a Type 3 Certification in accordance with Sections 106-3 for all new reflective sheeting and a Type 7 Material Certification for all used sheeting on flagger vests prior to use.

(3) Approval

All materials are subject to the approval of the Engineer.

SECTION 1090
PORTABLE CONCRETE BARRIER

1090-1 PORTABLE CONCRETE BARRIER

(A) General

Use portable concrete barrier that meets all requirements of Section 854, Section 1077 and the plans.

(B) Used Portable Concrete Barrier

Used barrier will be acceptable provided the following conditions have been met:

(1) The Contractor has furnished a Type 7 material certification.

(2) The strength of the concrete in each barrier unit is at least 4500 psi as evidenced by nondestructive tests made in place by a rebound hammer in accordance with ASTM C805.

(C) Anchor Bolts

Use anchor bolts that meet the requirements of ASTM A325.

(D) Anchor Bolt Adhesives

Prior to application, test the adhesive for a tensile strength of 125% of the specified required yield load (42 kips) of the anchor bolt. Furnish certification that, for the particular bolt grade, diameter, and embedment depth required, the anchor system

will not fail by adhesive failure and that there is no movement of the anchor bolt. For certification and anchorage, use 3000 psi as the minimum portland cement concrete compressive strength used in this test.

Use adhesives that meet the requirements of Section 1081.

List the properties of the adhesive on the container and include density, minimum and maximum temperature application, setting time, shelf life, pot life, shear strength and compressive strength.

Package components of the adhesive in containers of such size that one whole container of each component is used in mixing one batch of adhesive. Design the containers to allow for all of the contents to be readily removed and be well sealed to prevent leakage. Furnish adhesive material that requires hand mixing in two separate containers marked as Component "A" and Component "B". A self contained cartridge or capsule consists of two components that will automatically be mixed as they are dispensed.

Clearly label each container with the manufacturer's name, date of manufacture, batch number, batch expiration date, all directions for use, and such warning of precautions concerning the contents as required by Federal or State Laws and Regulations.

(E) Approval

All materials are subject to the approval of the Engineer.

SECTION 1092

SIGNING MATERIALS

1092-1 SIGNS AND HARDWARE

Fabricate signs from aluminum alloy sheets. Use supporting frames and accessories made of aluminum. Use galvanized steel backing plates and mounting bolts. Use materials that conform to the requirements of Tables 1092-1 and 1092-2.

Filler metal shall conform to the requirements of Section 10(3) of the *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*.

Aluminum sign studs, welded to the sign panels in accordance with Article 901-3, shall be capable of withstanding a direct pull-out load of 400 pounds. Furnish a Type 3 Manufacturer's Certification demonstrating conformance to this requirement. The Materials and Tests Unit will take samples of the studs, and make random field tests of the welded studs to verify the statement of certification. Failure of more than 10 percent of the studs tested on any one sign will be considered sufficient evidence for rejection of stud welding on the entire sign. When tested in tension, the studs shall not fail in the weld area, but fail in the threaded portion of the stud.

TABLE 1092-1
ALUMINUM SIGN MATERIALS

Aluminum Materials	Alloy	ASTM Spec.
Extruded Bars	6061-T6	B221
Sheets and Plates	6061-T6,5052-H38, or 3004-H38	B209
Structural Shapes	6061-T6	B308
Standard Weight Pipe	6061-T6	B241
Castings	356-T7	B26
Bolts	6061-T6	B211
Nuts (1/4" Tap and under)	6061-T6	B211
Nuts (5/16" Tap and over)	6061-T6 or 6262-T9	B211
Washers (std. flat) Alclad	6061-T6	B209
Washers (std. lock)	7075-T6	B211
Welded Studs (1/4")	5356-H12 or 5356-H32	B211

TABLE 1092-2
STEEL SIGN MATERIALS

Galvanized Steel Materials	ASTM Spec. for Base Metal	ASTM Spec. for Galvanizing
Structural Shapes and Plates	A36	A123
Standard Weight Black Pipe	A53	A123
Bolts and Nuts	A307	A153
Washers (std. flat and lock)	A307	A153
High Strength Bolts, Nuts & Washers	A325	A153

Drill bolt holes and slots to finished size or they may be punched to finished size, provided the diameter of the punched holes is at least twice the thickness of the metal being punched. Flame cutting of bolt holes and slots will not be permitted. No galvanizing of any steel part will be allowed until all welding, cutting, milling, punching, and drilling of the part has been completed.

1092-2 RETROREFLECTIVE SHEETING

General Requirements

Reflectorize all signs as described in Section 1093. Use colors and sheeting types of the sign backgrounds and messages as shown in the contract. After preparation of the sign panels, in accordance with the requirements of Subarticle 901-3(D), apply retroreflective sheeting as required herein.

1092-3 CERTIFICATION

Provide a Type 6 Supplier's certification for all retroreflective sheeting used in the manufacture of the signs certifying that the sheeting meets all the requirements of Section 1092.

1092-4 VERY HIGH BOND TAPE

Provide a Type 6 Supplier's certification for all very high bond acrylic foam tape used in the manufacture of the signs certifying that the tape meets all the requirements of this section. The very high bond tape shall be Acrylic Foam Tape with a nominal thickness of 0.045" and a tensile adhesion of at least 140 psi. The tape shall also be capable of a 90 degree peel adhesion of at least 25 lbs./in. Apply the tape per manufacturer's instructions and as shown on standard drawings.

SECTION 1093
RETROREFLECTIVE SHEETING

1093-1 GENERAL

This section includes requirements for flexible retroreflective sheeting designed to reflectorize highway signs, delineators, barricades, and other devices. The retroreflective sheeting shall consist of white or colored sheeting having a smooth outer surface and the property of a retroreflector over its entire surface.

Retroreflective sheeting shall meet the requirements of ASTM D-4956, and all the requirements of these Specifications. In case of conflict, the requirements of the Standard Specifications will prevail.

The reflective material specified herein is intended for use on surfaces of various traffic control devices, including drums, barricades, traffic cones, and highway signs, to assure their adequate visibility at all times upon exposure to a light source when totally dry or wet. Provide reflectorization that produces a wide-angle retroreflectivity, enhancing nighttime visibility. This retroreflective sheeting shall consist of encapsulated or enclosed lens or microprismatic elements embedded with a transparent plastic having a smooth, flat outer surface. Provide material that is flexible, of good appearance, free from ragged edges, cracks, and extraneous materials, and exhibits good quality workmanship.

1093-2 PHYSICAL REQUIREMENTS

(A) Prequalification

Obtain retroreflective sheeting on the Traffic Engineering Qualified Products List (QPL) for permanent sign sheeting. While the specific products are in the pre-qualification process, the product will be assigned the status of *TU* Trial Use. After satisfactorily completing the QPL process, the product will be assigned the status of *AU* Approved for Use.

(1) Approved Products List

To be approved for the QPL, the manufacturer shall satisfactorily complete item (a) or (b), and (c) below:

(a) National Transportation Product Evaluation Program

Provide certified test data showing that the representative production material of the type and colors, and films and inks to be supplied has met the requirements for the accelerated outdoor weathering. Weather

the sample test panels at a test facility run by the AASHTO National Transportation Product Evaluation Program.

Meet all requirements of the Specifications for the specific type of sheeting after weathering. See Subarticle 1093-2 (E) (14).

(b) Similar Climatic Conditions

Provide written documentation that the representative production material of the type and colors, and films and inks to be supplied has been used successfully in a substantial traffic signing program in similar climatic conditions for at least two years.

Meet the requirements of the Specifications and in the judgment of the Engineer; demonstrate the capability of meeting the requirements of Subarticle 1093-2 (E)(16) - Field Performance for the specific type of sheeting during use.

(c) Department of Transportation and the N. C. Department of Correction Pre-qualification Fabrication Testing

Time frames for beginning testing will be at the discretion of the Department. The testing will consist of the sign fabrication process and an observation period. During the testing, meet all the requirements of the current contract for the sheeting type held by NCDOA and meet all the requirements of the Specifications for the specific type of sheeting.

Provide the following for testing:

All required materials, including inks, processing colors and additives and any special packaging requirements for the specified project at a cost equal to or less than the current contract for the sheeting type held by the NCDOA.

A warranty on the signs equal to that of the current contract for the sheeting type held by NCDOA.

An on-site technical service and support representative during the initial fabrication of the test signs.

The necessary technical service, training, and support in order to have the sheeting material fully evaluated during the sign fabrication process.

The testing will consist of the sign fabrication process.

During the testing, meet all requirements of the Specifications and in the judgment of the Engineer, demonstrate the capability of meeting the requirements of 1093-2 (E)(9) - Field Performance for the specific type of sheeting.

(2) Re-Qualification

When changes have been made in the composition and/or manufacturing process of a preapproved material, a reevaluation of the

performance may be required. Changes that are detected in composition and/or manufacturing process, which have not been reported by the manufacturer to the State Traffic Engineer in writing prior to the Department receiving the material, may be grounds for removal of that material from the QPL and termination of the contract.

(B) Reference Documents

The following documents, of the issues in effect on the date of invitation for bids or request for proposal, form a part of this Specification:

ASTM D-4956-04 *Standard Specifications for Retroreflective Sheeting for Traffic Control*

(C) Classification

Retroreflective sheeting consists of white or colored sheeting having a smooth outer surface that has retroreflective properties over its entire surface.

(D) Test Panels

Unless otherwise specified herein, when tests are to be performed using test panels, apply the specimens of retroreflective material to smooth aluminum cut from ASTM B-209 Alloy 5052-H38, 3004-H38 or 6061-T6 sheets on 0.315 in, 0.394 in, or 0.063 in thickness and reclaimed aluminum with 120 grit finish of the same thickness. Use aluminum that is chromate conversion coated in accordance with Department of Correction standard manufacturing procedures before the specimens are applied. Apply the specimens to panels in accordance with the manuals of the retroreflective sheeting manufacturer.

(E) Performance and Test Requirements

(1) Certification

Submit with each lot or shipment a certification that states that the material supplied will meet all the requirements listed herein.

(2) General Characteristics

Supply retroreflective sheeting that is free from damage, free from ragged edges, cracks, cuts, abrasions and extraneous materials on the surface of the material or on any layer of the material.

Furnish the retroreflective sheeting in rolls or sheets. When furnished in continuous rolls, the average number of splices shall not be more than 4 per 150 feet roll or more than 7 per 301 feet roll of material. Overlap splices 0.394 in + 0.118 in and suitable for continuous application as furnished.

The retroreflective sheeting surface shall be solvent resistant such that it may be cleaned with gasoline, VM&P naphtha, mineral spirits, turpentine, methanol, or xylol without damage to the material.

(3) Color

Maintain uniform color throughout the length of each roll (devoid of streaks). Maintain uniform nighttime reflected colors, devoid of streaks, and appear the same as daytime colors throughout the warranted service life.

(4) Screening Inks

Furnish a list of inks and clears (and the manufacturers thereof) which are compatible with and acceptable for use with the sheeting offered, without voiding the warranty. Inks are to be one part. The inks listed shall not require oven curing to achieve optimal bond to the sheeting. All inks shall be compatible with both jetzone conveyor and conventional drying ovens. When the standard highway color inks are applied to the sheeting in accordance with the manufacturer's manuals, meet 1093-2 (E)(5) and have the same satisfactory performance life noted in Table 1093-10 for the finished signs. Meet the requirements of the Department Furnished and Contractor Furnished sign Specification for ink separation and non-wets when applied per the manufacturer's manuals.

(5) Coefficient of Retroreflection

Determine the coefficients of retroreflection in accordance with ASTM D4956, for the minimum requirements of Tables 1093-1 through 1093-9 as specified.

TABLE 1093-1

Minimum Coefficient of Retroreflection for Type I
(Candelas Per Lux Per Square Meter)

Observation	Entrance							
Angle (o)	Angle (o)	White	Yellow	Green	Red	Blue	Brown	Orange
0.2	-4.0	70.0	50.0	9.0	14.5	4.0	1.0	25.0
0.2	30.0	30.0	22.0	3.5	6.0	1.7	0.3	7.0
0.5	-4.0	30.0	25.0	4.5	7.5	2.0	0.3	13.0
0.5	30.0	15.0	13.0	2.2	3.0	0.8	0.2	4.0

TABLE 1093-2

Minimum Coefficient of Retroreflection for Type III
(Candelas Per Lux Per Square Meter)

Observation	Entrance							
Angle (o)	Angle (o)	White	Yellow	Green	Red	Blue	Brown	Orange
0.2	-4.0	250.0	170.0	45.0	45.0	20.0	12.0	100.0
0.2	30.0	150.0	100.0	25.0	25.0	11.0	8.5	60.0
0.5	-4.0	95.0	62.0	15.0	15.0	7.5	5.0	30.0
0.5	30.0	65.0	45.0	10.0	10.0	5.0	3.5	25.0

TABLE 1093-3
Minimum Coefficient of Retroreflection for Type IV
(Candelas Per Lux Per Square Meter)

Obser-vation	Entrance								Fluorescent	Fluorescent	Fluorescent
Angle (o)	Angle (o)	White	Yellow	Orange	Green	Red	Blue	Brown	Yellow Green	Yellow	Orange
0.2	-4.0	360	270	145	50	65	30	18	290	220	105
0.2	30.0	170	135	68	25	30	14	8.5	135	100	50
0.5	-4.0	150	110	60	21	27	13	7.5	120	90	45
0.5	30.0	72	54	28	10	13	6	3.5	55	40	22

TABLE 1093-4
Minimum Coefficient of Retroreflection for Type V
(Candelas Per Lux Per Square Meter)

Observation	Entrance						
Angle (o)	Angle (o)	White	Yellow	Green	Red	Blue	Orange
0.2	-4.0	700.0	470.0	120.0	120.0	56.0	280.0
0.2	30.0	400.0	270.0	72.0	72.0	32.0	160.0
0.5	-4.0	160.0	110.0	28.0	28.0	13.0	64.0
0.5	30.0	75.0	51.0	13.0	13.0	6.0	30.0

TABLE 1093-5
Minimum Coefficient of Retroreflection for Type VI
(Candelas Per Lux Per Square Meter)

Obser-vation	Entrance							Fluorescent	Fluorescent	Fluorescent
Angle (o)	Angle (o)	White	Yellow	Orange	Green	Red	Blue	Yellow Green	Yellow	Orange
0.2	-4.0	500	350	125	60	70	45	400	300	200
0.2	30.0	200	140	50	24	28	18	160	120	80
0.5	-4.0	225	160	56	27	32	20	180	135	90
0.5	30.0	85	60	21	10	12	7.7	68	51	34

TABLE 1093-6
Minimum Coefficient of Retroreflection for Type VII
(Candelas Per Lux Per Square Meter)

Obser-vation	Entrance							Fluorescent	Fluorescent	Fluorescent
Angle (o)	Angle (o)	White	Yellow	Orange	Green	Red	Blue	Yellow Green	Yellow	Orange
0.2	-4.0	750	560	280	75	150	34	600	450	230
0.2	30.0	430	320	160	43	86	20	340	260	130
0.5	-4.0	240	180	90	24	48	11	190	145	72
0.5	30.0	135	100	50	14	27	6	110	81	41

TABLE 1093-7
Minimum Coefficient of Retroreflection for Type VIII
(Candelas Per Lux Per Square Meter)

Obser-vation	Entrance								Fluorescent	Fluorescent	Fluorescent
Angle (o)	Angle (o)	White	Yellow	Orange	Green	Red	Blue	Brown	Yellow Green	Yellow	Orange
0.2	-4.0	700	525	265	70	105	42	21	560	420	210
0.2	30.0	325	245	120	33	49	20	10	260	200	95
0.5	-4.0	250	190	94	25	38	15	7.5	200	150	75
0.5	30.0	115	86	43	12	17	7	3.5	92	69	35

TABLE 1093-8
Minimum Coefficient of Retroreflection for Type IX
(Candelas Per Lux Per Square Meter)

Obser-vation	Entrance							Fluorescent	Fluorescent	Fluorescent
Angle (o)	Angle (o)	White	Yellow	Orange	Green	Red	Blue	Yellow Green	Yellow	Orange
0.2	-4.0	380	285	145	38	76	17	300	230	115
0.2	30.0	215	162	82	22	43	10	170	130	65
0.5	-4.0	240	180	90	24	48	11	190	145	72
0.5	30.0	135	100	50	14	27	6	110	81	41
1.0	-4.0	80	60	30	8	16	3.6	64	48	24
1.0	30.0	45	34	17	4.5	9	2	36	27	14

TABLE 1093-9
Minimum Coefficient of Retroreflection for Type X
(Candelas Per Lux Per Square Meter)

Obser-vation	Entrance								Fluorescent	Fluorescent	Fluorescent
Angle (o)	Angle (o)	White	Yellow	Orange	Green	Red	Blue	Brown	Yellow Green	Yellow	Orange
0.2	-4.0	560	420	210	56	84	28	17	450	340	170
0.2	30.0	280	210	105	28	42	14	8.4	220	170	84
0.5	-4.0	200	150	75	20	30	10	6	160	120	60
0.5	30.0	100	75	37	10	15	5	3	80	60	30

For areas printed with transparent colors, the coefficient of retroreflection shall not be less than 70% of the values for the corresponding color in Tables 1093-1 through 1093-9.

(6) Color Processing

Maintain heat resistance and permit curing without staining of applied or unapplied sheeting at temperatures recommended by the sheeting manufacturer.

(7) Adhesive

Utilize a precoated pressure sensitive adhesive (Class 1) or a tack-free adhesive (Class 2) activated by heat applied in a vacuum applicator in a manner recommended by the sheeting manufacturer's manuals, which is capable of being applied to new aluminum without additional adhesive coats on the reflective sheeting or substrate material. Protect the adhesive by an easily removable liner.

When reclaimed aluminum is used, the adhesive shall adhere to reclaimed aluminum with a minimum 120 grit finish without additional adhesive coats. Sheeting will be applied immediately or aluminum will be processed by chromate conversion.

(8) Outdoor Weathering

The sample test panels will be weathered at test facilities run by the AASHTO National Transportation Product Evaluation Program. Maintain a weather resistant retroreflective surface that shows no cracking, blistering, crazing, dimensional change or delaminating during the exposure period. At the end of the exposure period, conform to the requirements of Table 1093-10 as appropriate for the sheeting type.

(9) Field Performance

The fabricating agency will date all signs (month, year) at the completion of fabrication. That date constitutes the start of the field performance obligation period.

The retroreflective sheeting will be considered unsatisfactory if it has deteriorated due to any cause except defacement resulting from vandalism or damage resulting from impact by a motor vehicle or other object to the extent that

(a) The sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving conditions, or

(b) The coefficient of retroreflection is less than the minimum specified for that sheeting during that period listed in Table 1093-10 when measured by the Delta RetroSign retroreflectometer, or

(c) The screened message and border or reverse screened background has stained, discolored, streaked, faded, turned dark or has developed cracks, scaling, pitting and/or blistering, or

(d) The sign is unsatisfactory with regard to uniform appearance due to cracking, streaking, delamination, blistering, crazing, or discoloration of the sheeting, or

(e) The sign is unsatisfactory with regard to remaining uniform in color over the entire reflecting surface both day and night and displaying the same color both in daylight and under lights at night.

(i) For glass bead material, sheeting will be subjected to a visual test with the human eye as the test instrument. Objectionable non-uniformity of color and reflectivity (retroreflection) under light at night is cause for the sign to be tested for retroreflection to determine compliance with the following requirements:

The retroreflection values on any sign shall not vary from each other by more than a ratio of 1.10 (1.20 white) at any two points at least 12 in apart, nor more than 1.30 (1.30 white) at any two points anywhere on the sign, nor more than, 1.10 (1.20 white) at any two points on the border or between any two adjacent letters, numerals, or symbols. Failure to meet the above requirements will result in sign rejection. Retroreflection will be tested using a Delta RetroSign Retroreflectometer.

(ii) For prismatic material, sheeting will be subjected to a visual test with the human eye as the test instrument.

TABLE 1093-10
MINIMUM COEFFICIENT OF RETROREFLECTION
Candelas per Lux per Square Meter
(.2º DIV. and -4º INCIDENCE) (*)

Type	Months [A]	Minimum Coefficient of Retroreflection
I	24[B]	50% of Table 1
III	36[B]	80% of Table 2
IV	36[B]	80% of Table 3
V	36[B]	80% of Table 4
VI	6	50% of Table 5
VII	36[B]	80% of Table 6
VIII	36[B]	80% of Table 7
IX	36[B]	80% of Table 8
X	36[B]	80% of Table 9

(*) Make all measurements after sign cleaning.

[A] Testing at shorter intervals may be done to gather additional information

[B] When the colors yellow, white, or fluorescent orange are specified for construction work zone applications, the outdoor weathering time will be 12 months.

(F) Manufacturer's Warranty and Obligations

(1) Warranty

The sheeting manufacturer warrants to the Department that all materials furnished under this Specification will be new, of good components and workmanship and agrees to the following conditions.

Retroreflective sheeting processed and applied to sign blank materials in accordance with the manufacturer's manuals shall be warranted by the manufacturer to perform effectively as stated in 1093 (E)(9) Field Performance. The manufacturer's manuals shall contain a complete descriptive explanation of all the requirements necessary of the sign fabricator.

(2) Obligation

Where the Specification and performance requirements have not been met, cover the sign costs as follows for each sheeting type.

(a) All Sheeting Types

When material fails to meet the Specification, prior to being applied to the sign blanks, give a financial credit for all defective sheeting at no cost to the Department. If the Department decides to use the sheeting, that in no way relieves the sheeting manufacturer from the obligation of the financial credit for the defective sheeting.

When material fails to meet the Specifications, after being applied to the sign blanks, while still at the sign fabricators facility, give a financial credit for all defective sheeting and cover the cost of the sign(s) at no cost to the Department. If the Department accepts the sign, that in no way relieves the sheeting manufacturer from the obligation of financial credit for the defective sheeting and covering the cost of the sign(s).

When material fails to meet the Specifications, after being installed, comply with 1093 (F)(2)(b) or (c) for the material type. In lieu of covering the cost as describe in 1093(F)(2)(b) or (c) below, the sheeting manufacturer may request to complete the work as required. The request shall include the name of the sign manufacturer, the name of the contractor who will install the signs, and a completion date for the work. The request will be reviewed for acceptance by the Department.

The sign fabricator shall use due diligence and not knowingly produce signs using defective sheeting. The ultimate responsibility for the sheeting quality is with the sheeting manufacturer. The sign fabricator is not required by the sheeting manufacturer to inspect the sheeting prior to use.

(b) Type I

Years 1 through 4 (years 1 through 3-orange) - Cover the cost of restoring the sign face in its field location to its original effectiveness including removal, materials, fabrication, erection, labor and equipment.

Years 5 through 7 (N/A for orange) -Replace the sheeting required to restore the sign face to its original effectiveness.

(c) Type III, IV, VII, VIII, IX, and X

Years 1 through 7 (years 1 through 2- fluorescent orange) - Cover the cost of restoring the sign face in its field location to its original effectiveness at no cost to the Department for materials, labor and equipment. In addition to the reflective requirements for Type VII, VIII, and IX fluorescent orange, the sheeting shall maintain a total Luminance Factor (Y) of 25 (ASTM D4956) and a Fluorescence Luminance Factor (Y_F) of 13% (ASTM E2301) for 3 years. Maintain 80% of fluorescent orange sheeting reflectivity for years 1 and 2.

Years 8 through 10 (year 3 fluorescent orange) -Replace the sheeting required to restore the sign face to its original effectiveness. Maintain 50% of fluorescent orange sheeting reflectivity for year 3.

Years 11 through 12 - Replace 50% of the sheeting required to restore the sign face to its original effectiveness.

(G) Packaging

Pack the sheeting, rolls and sheets, snugly in corrugated fiberboard cartons, in accordance with commercially accepted standards. Stipulate clearly on each carton the brand, quantity, size, lot and run or drum number, color, type adhesive, invoice number/shipping number and month and year of manufacture on the end of the carton. Furnish retroreflective sheeting suitable for use when stored under NCDOC and NCDOT existing conditions for a maximum period of 18 months.

(H) Technical Assistance Requirements

Provide competent product information and technical services for the sheeting, inks and incidentals

(1) Instruction and Training

Have available instruction and training on an annual basis at no additional cost, including but not limiting training films or video tapes (if available), material application, equipment operation, silk screening techniques, packaging, storage and other proven sign shop practices as they apply to the reflective sheeting supplied by the manufacturer, and to assure that the resulting signs can comply with the applicable Specifications.

(2) Technical Assistance

To ensure continued quality sign manufacture, without additional cost, provide the State sign manufacturing facilities with on-site technical maintenance service by a qualified technician at the sign fabrication facilities designated by the DOC or DOT, as required. This technical service will include service for any process color or ink recommended insofar as it relates to the processing application on the sheeting.

Have available emergency on-site technical service without cost to the Department within 48 hours, Monday through Friday, and 72 hours during a weekend, upon proper notification by a fabricating agency of a production problem.

Provide a list of the technical service personnel and their qualifications to the Department.

(3) Inspection

All DOC, DOT and designated agencies shall be inspected by a qualified technician for conformance to manufacturer’s recommendations as stated in their manuals for warranty purposes on a semi-annual basis without cost to the Department. A written report of any discrepancy from those stated in the manufacture’s manual will be made to that agency and to the Department.

(4) Equipment

Provide technical service for recommended sheeting application, using owner's equipment, and certify that factory trained personnel will be available on 48 hours notice to render such service. "Service" is understood to mean the capability of calibration and trouble shooting, as well as the training and retraining of owner's personnel as required.

(I) Compliance

Failure to comply with this Specification is grounds for default of contract.

1093-3 CERTIFICATION

Have the retroreflective sheeting manufacturer provide certified test data showing that representative production material of the type to be supplied has met the requirements for accelerated weathering described elsewhere in this Specification.

Provide a Type 6 Supplier's certification for all retroreflective sheeting used in the manufacture of signs certifying that the sheeting meets all the requirements of Section 1093.

SECTION 1094
GROUND MOUNTED SIGNS

1094-1 GROUND-MOUNTED SIGN SUPPORTS.

(A) Breakaway or Simple Steel Beam Sign Supports

Fabricators of breakaway or simple steel beam sign supports shall be Category I Certified by the American Institute of Steel Construction.

Steel supports for Type A and B ground mounted signs shall be galvanized rolled steel sections, either breakaway or simple design, as required by the contract. Fabricate supports from plates, W shapes, and S shapes, as required by the contract, and they shall conform to ASTM A36. Splices in the supports will not be permitted. Perform galvanizing prior to assembly that conforms to ASTM A123. Cutting steel supports to length after they have been galvanized will not be permitted. The support(s) shall be uniformly straight to within 1/8" tolerance for pieces less than 20 feet in length, and 1/4" tolerance for pieces over 20 feet in length.

Fabricate high strength bolts, nuts, and washers required for breakaway supports from steel conforming to ASTM A325 and be galvanized in accordance with ASTM A153.

(B) 3-Lb. Steel U-Channel Posts

Make 3-lb. steel U-channel posts out of rerolled rail steel or new billet steel, conforming to the mechanical requirements of ASTM Specification A499, Grade 60, and the chemical requirements of ASTM A1, for rails having nominal weights of 91 pounds per yard or greater. Proportion the cross section so that a moment of 1,450 ft-lbs., applied to the cross section normal to the flanges, will produce an extreme fiber stress no greater than 39,500 psi. Use posts that weight 3 pounds per linear foot. Punch or drill all posts with 3/8" diameter holes on the centerline, spaced 1" on

centers, starting 1" from the top and extending to the bottom of the posts. Galvanize these posts after fabrication for the full length and total area in accordance with ASTM A123. The zinc coating inside of the 3/8" diameter holes shall not exceed Specification requirements enough to prevent a 5/16" diameter bolt from freely passing through.

Use U-channel post sections of the same general configuration as that shown in the contract, however minor variations may be considered acceptable by the Engineer provided all other requirements are met.

(C) 2-Lb. Steel U-Channel Posts

Use 2-lb. steel U-channel posts that are variable length galvanized steel, U-shaped channel posts.

Fabricate the U-channel posts from steel meeting the requirements of ASTM A366 or ASTM A499, or an approved alternate. The posts shall weigh 2 pounds per linear foot, and be of the length necessary to meet the erection requirements of the contract. Before galvanizing, punch or drill 3/8" diameter holes on 1" centers, beginning 1" from the top of the post, for a minimum distance equal to the vertical dimension of the respective sign or mile marker. Galvanize these posts after fabrication in accordance with ASTM A123. The zinc coating inside of the 3/8" diameter holes shall not exceed Specification requirements enough to prevent a 5/16" diameter bolt from freely passing through.

U-channel post sections shall be of the same general configuration as that shown in the contract, however, minor variations may be considered acceptable by the Engineer, provided all other requirements are met.

(D) Steel Square Tube Posts

Use steel square tube posts of variable length galvanized steel. The post shall be a minimum 14 gauge steel square tube. Before galvanizing punch or drill all posts with 3/8" diameter holes on the centerline, spaced 1" on centers, starting 1" from the top and extending to the bottom of the posts.

Galvanize these posts after fabrication for the full length and total area in accordance with ASTM A123. G90 zinc coating shall not be accepted. The zinc coating inside of the 3/8" diameter holes shall not exceed Specification requirements enough to prevent a 5/16" diameter bolt from freely passing through.

Steel square tube sections shall be of the same general configuration as that shown in the contract, however, minor variations may be considered acceptable by the Engineer, provided all other requirements are met.

(E) Wood Supports

Wood supports shall conform to Articles 1082-2 and 1082-3.

1094-2 RIVETS FOR SIGN OVERLAYS

Rivets for sign overlays shall be 1/8" diameter aluminum rivets of the pull through type, and be approved by the Engineer. Submit for approval several samples of rivets, along with adequate descriptive catalog literature.

SECTION 1096
OVERHEAD SIGN STRUCTURES

1096-1 ALUMINUM OVERHEAD SIGN STRUCTURES

Materials for aluminum overhead sign structures shall conform to the applicable requirements of Article 1092-1, and the requirements of the latest edition of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* with the latest interim specifications. Where the Contractor proposes to use materials that are not covered by these references, such use will be contingent on the Engineer's approval of these materials.

1096-2 STEEL OVERHEAD SIGN STRUCTURES

Use Category I certified by the American Institute of Steel Construction Fabricators for steel overhead sign structures as required by Section 1072-1 (A). Use either structural carbon steel or structural low-alloy steel for steel overhead sign structures meeting the requirements of the *Standard Specifications for Highway Bridges*. Other steel may be used, subject to the approval of the Engineer. Structural steel that has been cold-rolled to increase the yield strength will be permitted. Mechanically galvanize all fasteners. Hot-dip galvanize all other components of the structural assembly after fabrication has been completed. The galvanizing shall meet the requirements of ASTM A153 for fasteners and of ASTM A123 for other structural steel.

1096-3 WELDING

Perform all welding in the fabrication of the supports by AWS certified welders. Furnish a copy of the AWS certification for each welder used for fabrication. All welds shall be free of cracks, blow holes, slag, and other irregularities, and be wire brushed, sandblasted, or otherwise cleaned.

Aluminum welding processes and procedures, shielding gases, preparation, weld quality, inspection and correction of welds, and the qualification of welding procedures, welders, and welding operators will be governed by the latest edition of AWS Structural Welding Code, D1.2 -- Aluminum as described in the *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*.

The welding of steel components, including structural details, filler metal, workmanship and technique, qualification and inspection will be based on the applicable requirements of the AWS Bridge Welding Code, D1.5.

SECTION 1097
SIGN LIGHTING SYSTEMS.

1097-1 ELECTRICAL INDUSTRY STANDARDS

An electrical industry standards organization acceptable to the Engineer shall label or list all electrical materials. The listing organization shall maintain periodic inspection of the production of materials and shall, by the labeling or listing procedure, verify that the materials comply with appropriate standards of performance or are suitable for use in

a specified manner. Provide Underwriters Laboratories (UL) labeled and listed materials whenever such labeling and listing is available for such materials.

1097-2 HIGH PRESSURE SODIUM LUMINAIRES

Use luminaires which provide an average of 30 ±2 maintained footcandles, with a maximum to minimum uniformity ratio of no more than 5:1 on the sign face at 77° F. Use luminaires that provide this intensity as a minimum average after applying a lamp lumen depreciation (LLD) factor of 0.90 and a luminaire dirt depreciation (LDD) factor of 0.90.

Use single-lamp type luminaires with heavy-duty mogul lamp socket and lamp grip, and with the ballast mounted internally or immediately adjacent. Use luminaires that provide the required lighting intensity when spaced as shown in the contract or on approved shop drawings.

Use luminaire and ballast enclosures constructed of corrosive-resistant steel or aluminum material with sealed, charcoal filtered optics. Provide luminaires that have access doors with hinges and latches.

Use a glass refractor or lens that is tempered for resistance to shock and thermal stresses, and which is single-piece prismatic-molded with appropriate reflector inserts. Use gaskets made of neoprene, silicone, rubber, or continuous sponge rubber types, and that are adequate to keep out moisture, dust and insects.

Use ballasts that are 120-volt, 60-cycle, constant wattage, autotransformer type, and which conform to ANSI S54 for 100W luminaires, ANSI S55 for 150-watt luminaires, ANSI S50 for 250-watt luminaires, or ANSI S51 for 400-watt luminaires. Use only ballasts which have power factor ratings of 90% or higher, and are capable of starting the lamp at -20° Fahrenheit. Use ballasts that provide the starting and operating current specified in shop drawings or catalog cuts.

Provide luminaires that have a wattage rating as shown in the contract or on approved shop drawings. Use luminaires constructed in such a way that no live parts are exposed when the lamp is replaced. Terminate all wiring connections for lamps and ballasts on terminal blocks, with all wiring clearly identified by color and/or number.

Use UL listed luminaires labeled for wet locations and which conform to UL Standard 1572 High Intensity Discharge Lighting.

1097-3 LAMPS

Use lamps that conform to ANSI specifications, and are of the wattage shown in the contract. Unless otherwise shown in the contract, use clear high pressure sodium lamps of ANSI types S54SB-100 (100-watt), S55SC-150 (150-watt), S50VA-250/S (250-watt), or S51WA-400 (400-watt). Use only lamps rated at 23,000 hours life for continuous duty and 24,000 hours life for intermittent operation. Ensure that lamp output designations and ballast ratings agree. Use only heavy-duty mogul type bases.

1097-4 FORMED CHANNEL

Use only hot-dipped galvanized steel or extruded aluminum formed channels. Use steel channels that meet the requirements of ASTM A36 and are hot-dipped galvanized in

accordance with ASTM A123. Use steel fittings, nuts, bolts, washers, and related hardware with steel channels, and which meet the requirements of ASTM A307 and are hot-dipped galvanized in accordance with ASTM A153. Use alloy 6061-T6 extruded aluminum channels, nuts, and bolts, alloy 7075 lock-washers, and Alclad 2024 flat washers. You may use stainless steel hardware with either aluminum or hot-dipped galvanized steel channels.

1097-5 CONDUIT, BOXES, AND FITTINGS

Use conduit, boxes, and fittings of the type and size shown in the contract.

Use metallic conduit and duct that is rigid hot-dipped galvanized steel and meets the requirements of UL Standard 6 Rigid Metallic Conduit, with rigid full weight sherardized or galvanized threaded fittings.

Use rigid PVC (polyvinyl chloride) heavy wall non-metallic conduit and duct approved for above ground and underground use without concrete encasement in accordance with UL Standard 651 Rigid Non-Metallic Conduit.

Use liquid-tight metallic flexible conduit meeting the requirements of UL Standard 360 Liquid-Tight Flexible Steel Conduit, Electrical that is acceptable for equipment grounding, with insulated throat, grounding, and malleable iron watertight fittings.

Use watertight hot-dipped galvanized steel conduit bodies, boxes, and fittings meeting the requirements of UL Standard 514 B Fittings for Conduit and Outlet Boxes.

1097-6 WIRE AND CABLE

Use only stranded copper conductors, unless otherwise shown in the contract or Specifications. Provide wire and cable with identification labels or tags on either the wire or cable itself or on the coil, reel, or smallest container in which the product is packaged when delivered to the project. Show the manufacturer's name, gauge, UL symbol, and type of wire or cable on the identification label or tag.

Use wire and cable of the type and size shown in the contract, and which meets the requirements of the following standards:

UL Standard 44,	Rubber-Insulated Wires and Cables
UL Standard 83,	Thermoplastic-Insulated Wires and Cables
UL Standard 493,	Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables
UL Standard 719,	Nonmetallic-Sheathed Cable
UL Standard 854,	Service-Entrance Cables
UL Standard 1063,	Machine-Tool Wires and Cables
UL Standard 1581,	The Reference Standard for Electrical Wires, Cables, and Flexible Cords

1097-7 POLES

Provide treated poles that meet the requirements of Article 1082. Use 30' Class 5 poles unless otherwise shown in the contract.

1097-8 SWITCHES

Use safety disconnect switches rated as shown in the contract, and which meet the requirements of UL Standard 98 Enclosed and Dead-Front Switches. Use heavy duty, NEMA 3R disconnect switches with provisions for locking by padlock, and with neat and permanent labels as shown on the contract.

1097-9 CIRCUIT BREAKERS AND PANELS

Use circuit breakers and panels that meet the requirements of UL Standard 489 Molded-Case Circuit Breakers and Circuit-Breaker Enclosures, and UL Standard 67 Electric Panelboards.

Use only molded case, thermal magnetic trip type breakers. Use circuit breakers and circuit breaker panelboard with NEMA 3R enclosures, marked as suitable for use as service equipment, and neatly and permanently labeled as shown on the contract. Provide only circuit breaker panelboard enclosures that are lockable with padlocks.

1097-10 PHOTOCELL CONTROLLERS

Use plug-in photo-controllers of the cadmium-sulfide type, suitable for use in an operating voltage range of 105-285 volts and nominal control voltages of 120, 208, 240, and 277 volts. Use a control rated for 1000 watts resistive load or 1800 volt-amperes inductive load with a light-level setting that is within a range of 1.0 to 3.0 footcandles at 120 volts.

Use controls that have internal protection for surges in excess of 2000 volts peak. Provide a receptacle suitable for mounting directly to the top of a pole. Use a control and receptacle that conform to NEMA Standard SH16 Physical and Electrical Interchangeability of Light Sensitive Control Devices Used in the Control of Roadway Lighting, and neatly and permanently label them as shown on the contract.

1097-11 CONTACTORS

Use electrically held contactors which are full current rated for the control of fluorescent and HID lighting loads, and which are 60 amp, 2 pole with 120 VAC coil unless otherwise called for in the contract. Use NEMA designed contactors with replaceable coil and contacts, which are controlled by a selector switch and photo control as shown in the contract, and which are neatly and permanently labeled as shown on the contract.

Provide an enclosure for the contactor which is a lockable (with padlock) NEMA 3R unit and includes an internally mounted selector switch, control circuit fuse, neutral bar, and equipment grounding bar if shown in the contract.

Use a contactor and enclosure that conform to UL Standard 508 Electric Industrial Control Equipment.

1097-12 TRANSFORMERS

Use transformers of single-phase, dry, step-down voltage (480 V-240/120 V) type, rated for outdoor use (NEMA 3R), of the size (KVA) noted in the contract, and which conform to UL Standard 506 Specialty Transformers.

1097-13 ENCLOSURES

Provide stainless steel NEMA 4X enclosures when the enclosure contains a combination of electrical components, including switches, circuit breakers, and contactors. Use enclosures of the size shown in the contract conforming to UL Standard 508 Electric Industrial Control Equipment. Use an enclosure with a gasket door lockable by padlock, with a 2 or 3 point latching mechanism, and with a painted back panel for mounting components. Use enclosures that have external integral mounting lugs or mounting lugs that are factory welded to the enclosure. If shown in the contract, mount a handle in the flange of the enclosure to operate a circuit breaker or disconnect switch. Use an operator handle that can be locked in the ON position, and that is interlocked with the latching mechanism to prevent opening of the door when in the ON position except with safety over-ride devices. Provide a plan pocket on the inside of the door.

Provide a mill finish aluminum meter base acceptable to the utility company that provides the power.

1097-14 LOCKS

Use key operated, pin tumbler, dead bolt padlocks with brass or bronze shackle and case, meeting the requirements of Military Specification MIL-P-17802E (Grade I, Class 2, Size 2, Style A). Key all padlocks alike.

1097-15 STRAPPING AND HARDWARE

Use stainless steel straps and buckles, meeting the requirements of ASTM A666 which are a minimum of 1/2" wide and .030" thick and which are capable of withstanding a breaking strength tension pull of 1500 pounds before failure.

Use 1/4" stud type concrete expansion anchors which provide a minimum safe holding capacity of 550 pounds , based on 25% of the actual pullout capacity of the anchor in 3000 psi concrete, as determined by an approved testing laboratory.

Use only aluminum, stainless steel, or hot-dipped galvanized steel hangers, screws, lags, bolts, nuts, or other devices used to support conduit.

1097-16 GROUNDING AND BONDING EQUIPMENT

Use ground clamps, grounding and bonding bushings, lock nuts, and grounding electrodes that comply with UL Standard 467 Electric Grounding and Bonding Equipment. Use 5/8" diameter, 10 foot long, copper-clad steel ground rods.

SECTION 1098
SIGNALS AND INTELLIGENT TRANSPORTATION SYSTEMS MATERIALS

1098-1 GENERAL REQUIREMENTS

(A) Qualified Products

Furnish new equipment, materials, and hardware unless otherwise required. Inscribe manufacturer’s name, model number, serial number, and any additional information

needed for proper identification on each piece of equipment housed in a case or housing.

Signal Equipment Qualified Products List (QPL) is available on the Department's website.

Certain signal and communications equipment, material, and hardware shall be pre-approved on the QPL by the date of installation. Equipment, material, and hardware not pre-approved when required will not be allowed for use on the project. Consult the QPL web site to obtain pre-approval procedures.

(B) Submittal Requirements

Provide written certification to the Department that all Contractor-furnished material is in accordance with the contract. When requested by the Department, provide additional certifications from independent testing laboratories and sufficient data to verify item meets applicable Specifications. Ensure additional certification states the testing laboratory is independent of the material manufacturer and neither the laboratory nor the manufacturer has a vested interest in the other.

Identify all proprietary parts in Contractor-furnished material. The Department reserves the right to reject material that uses proprietary components not commercially available through electronic supply houses.

For Contractor-furnished material listed on the QPL, furnish submittals in the format defined by the QPL.

For Contractor-furnished material not on the QPL, furnish three copies of the equipment list including three copies of catalog cuts. Identify proposed material on catalog cuts by a reproducible means (highlighter pen does not transfer to copies). Ensure material lists contain material description, brand name, manufacturer's address and telephone number, stock number, size, identifying trademark or symbol, and other appropriate ratings.

Do not fabricate or order material until receipt of the Engineer's approval.

(C) Observation Period

Warrant workmanship and Contractor-furnished equipment for a 30-day observation period under the payment and performance bond from date of acceptance.

If workmanship or equipment fails during the 30-day observation period, repair or replace with new equipment and begin a new 30-day observation period.

The observation period for this work is not part of the work to be completed by the project completion date.

(D) Warranties

Unless otherwise required herein, provide manufacturer's warranties on Contractor-furnished equipment for material and workmanship that are customarily issued by the equipment manufacturer and that are at least two years in length from successful completion of the 30-day observation period. Include unconditional coverage for all

parts and labor necessary or incidental to repair of defective equipment or workmanship and malfunctions that arise during warranty period.

Ensure all contractor-furnished equipment, including pieces and components of equipment, hardware, firmware, software, middleware, internal components, and subroutines which perform any date or time data recognition function, calculation, or sequencing will support a four digit year format for a period of at least 50 years.

Upon successful completion of the 30-day observation period, transfer manufacturer's warranties with proper validation by the manufacturer to the Department or its designated maintaining agency.

(E) Firmware Licensing and Upgrades

Provide the Department with a license to duplicate all programmable devices in equipment for maintenance and software upgrades. Provide binary or hexadecimal format files for each device that may be programmed by the Department. Ensure files are provided on PC compatible compact disks or other approved media.

Ensure firmware performance upgrades that occur during the contract period are available to the Department at no additional cost.

Make firmware upgrades that are developed to correct operating characteristics available to the Department at no additional cost until the warranty period expires.

(F) Plan of Record Documentation

Before final acceptance, furnish plan of record documentation of all fieldwork. Plan of record documentation will be subject to approval before final acceptance. Store documentation in a manila envelope placed in a weatherproof holder mounted within each cabinet or housing for easy access.

Except for standard bound manuals, bind all 8 1/2" x 11" documentation, including 11" x 17" drawings folded to 8 1/2" x 11", in logical groupings in either 3-ring or plastic slide-ring loose-leaf binders. Permanently label each grouping of documentation.

Provide manual, electrical schematic diagram, and cabinet wiring diagram for each control equipment cabinet and piece of equipment in cabinet. Place manuals and prints in weatherproof holder. For wiring diagrams and electrical schematic diagrams not bound into printed manuals, provide copies at least 22" x 34".

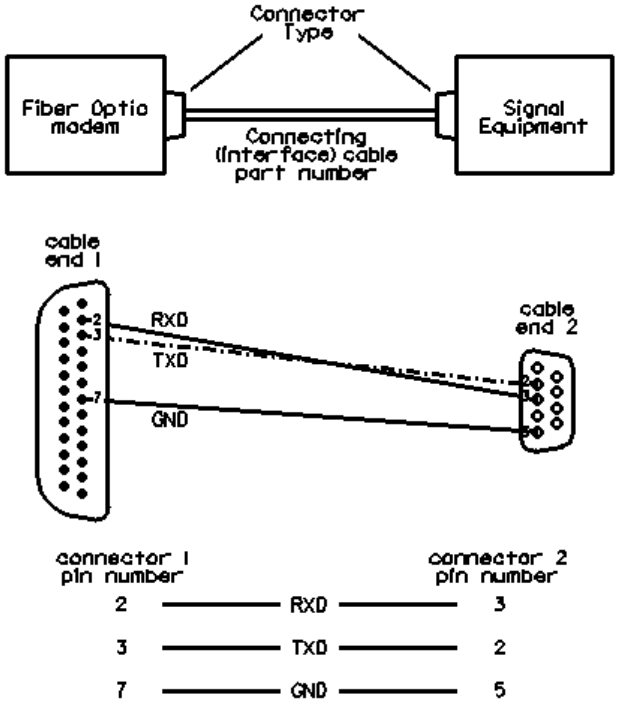
Provide Operator's Manuals containing detailed operating instructions for each different type or model of equipment. Ensure manuals contain instructions for possible modification to equipment.

Provide maintenance procedures manuals containing detailed preventive and corrective maintenance procedures for each different type or model of equipment.

Provide detailed wiring diagrams that include interconnection of equipment with pin-out configurations, pin functions, and cable parts numbers. For communications systems, camera systems, video imaging loop emulator detection systems, intelligent transportation systems, closed loop signal systems, and other computerized systems,

provide two copies of system connection diagrams showing system interconnection cables and associated terminations.

Example:



(G) Wire and Cable

Furnish wire and cable on reels. When requested by the Department, furnish samples of wire and cable to the Department at no additional cost.

Provide either 0.05" x 0.30" aluminum wrapping tape or 0.06" stainless steel lashing wire for lashing cables to messenger cable. Use 0.045" stainless steel lashing wire to lash fiber-optic communications cable to messenger cable.

(H) Electrical Service

Furnish external electrical service disconnects with single pole 50 ampere circuit breaker with a minimum of 10,000 RMS symmetrical amperes short circuit current rating in a lockable NEMA 3R enclosure. Ensure service disconnects are UL listed and marked as being suitable for use as service equipment. Fabricate enclosure from galvanized steel and electrostatically apply dry powder paint finish, light gray in color, to yield a minimum thickness of 2.4 mils. Provide ground bus and neutral bus with a minimum of four terminals with minimum wire capacity range of number 14 through number 4.

Furnish NEMA Type 3R outdoor enclosure, 100 Ampere rated meter base. Furnish 4 terminal, 600 volt, single phase, 3 wire meter base that complies with the following:

Line, Load, and Neutral Terminals accept #8 to 2/0 AWG Copper/Aluminum wire
Ringless Type without bypass

Made of galvanized steel
Meets Standard UL-414
Overhead or underground service entrance as specified

Provide meter bases with ampere rating of meter sockets based on sockets being wired with minimum of 167 degrees F insulated wire. Ensure meter bases have electrostatically applied dry powder paint finish, light gray in color, with minimum thickness of 2.4 mils.

Furnish 1" watertight hub for threaded rigid conduit with meter base.

If meter base and electrical service disconnect are supplied in the same enclosure, ensure assembly is UL listed and marked as being suitable for use as service equipment.

(I) Painting

Where painting of signal equipment cabinets, signal heads, signal poles, and pedestals is required, apply paint at the factory. No field painting will be allowed except when paint has been scratched or marred. In such cases, apply two field coats of the same color and grade enamel as the original paint to the scratched or marred portions.

1098-2 BACKPLATES

Comply with ITE standard *Vehicle Traffic Control Signal Head*. Provide backplates specific to the manufacturer of the vehicle signal heads.

Fabricate backplates for vehicle signal heads from sheet aluminum a minimum of 0.05" thick. Provide stainless steel fasteners for attachment to signal head.

Provide backplates painted an alkyd urea black synthetic baking enamel with minimum gloss reflectance that meets MIL-E-10169, *Enamel Heat Resisting, Instrument Black*.

Provide backplates that extend a minimum of 5" from the vehicle signal head outline. Ensure the backplate fills in the gaps between cluster-mounted vehicle signal sections (five-section vehicle signal heads). A 1/4" maximum gap between vehicle signal head and backplate, as viewed from the front, will be allowed.

1098-3 MESSENGER CABLE

Comply with ASTM A 475 for extra high strength grade wire strand, Class A zinc coating. Fabricate messenger cable from seven steel wires twisted into a single concentric strand.

Provide universal grade strandvises used for extra high strength steel messenger cable. Provide other pole line hardware constructed of hot-dipped galvanized steel. Provide machine bolts, eyebolts, and thimbleye bolts with minimum tensile strength of 12,400 lbs. Provide galvanized nuts, washers, and thimbleyelets.

1098-4 CONDUIT

(A) General

Use conduit bodies, boxes, and fittings that meet UL Standard 514B Conduit, Tubing, and Cable Fittings for electrical and communications installations.

(B) Conduit Types

(1) Rigid Metallic Conduit

Provide rigid hot dipped galvanized steel conduit that meets UL Standard 6 Electrical Rigid Metal Conduit-Steel with rigid full weight sherardized or galvanized threaded fittings.

(2) Polyvinyl Chloride (PVC)

Provide non-metallic conduit and duct including associated couplings, approved for above and below ground use with or without concrete encasement in accordance with UL Standard 651A *Type EB and A Rigid PVC Conduit and HDPE Conduit*. Provide Schedule 40 conduit unless otherwise specified.

(3) Liquid-Tight Metallic Flexible Conduit

Provide conduit that meets UL Standard 360 *Liquid-Tight Flexible Steel Conduit* that is acceptable for equipment grounding in accordance with the NEC. Ensure conduit has insulated throat and malleable iron watertight fittings.

(4) High Density Polyethylene Conduit (HDPE)

Provide HDPE conduit with an outer diameter to minimum wall thickness ratio that complies with ASTM D 3035, Standard Dimension Ratio (SDR) 13.6. Provide conduit that meets UL Standard 651B *Continuous Length HDPE Conduit*.

Provide conduit that meets the following:

ASTM D 638	Tensile Strength – 3,000 psi, min; Elongation – 400 percent, min
ASTM D 1238	Melt Index – 0.4 maximum
ASTM D 1505	Density – (0.941-0.955g/cc)
ASTM D 1693	Condition B – 20 percent failure, maximum
ASTM D 2444	Impact – NEMA Standards Publication Number TC7
ASTM D 3350	Cell Classification – 334420 or 344420

Ensure HDPE conduit is resistant to benzene, calcium chloride, ethyl alcohol, fuel oil, gasoline, lubricating oil, potassium chloride, sodium chloride, sodium nitrate, and transformer oil, and is protected against degradation due to oxidation and general corrosion. Furnish conduit with a coefficient of friction of 0.09 or less in accordance with Telcordia GR-356.

Furnish factory lubricated, low friction, coilable, conduit constructed of HDPE. Furnish conduit with nominal diameter as required. Provide conduit with smooth outer wall and ribbed inner wall. Ensure conduit is capable of being coiled on reels in continuous lengths, transported, stored outdoors, and

subsequently uncoiled for installation without affecting its properties or performance.

(C) Conduit Plugs, Pull Line, and Tracer Wire

Furnish duct plugs that provide a watertight barrier when installed in conduit. Furnish duct plugs sized in accordance with conduit. Ensure duct plug provides a means to secure a pull line to the end of the plug. Provide removable and re-usable duct plugs.

Furnish mechanical sealing devices that provide a watertight barrier between conduit and cables in conduit. Furnish mechanical sealing devices sized in accordance with conduit and with appropriately sized holes to accommodate and seal cables. Provide removable and re-usable mechanical sealing devices.

Furnish 1/2", pre-lubricated, woven polyester tape, pull line with minimum rated tensile strength of 2,500 lb.

Provide green insulated number 14 AWG, THW, stranded copper wire to serve as tracer wire.

Comply with Subarticle 1400-2(H) Duct and Conduit Sealer.

1098-5 JUNCTION BOXES

(A) General

Comply with Article 1411-2 Electrical Junction Boxes except as follows:

Provide junction box covers with standard *Traffic Signal* or *NCDOT Fiber Optic* logos, pull slots, and stainless steel pins.

Do not provide sealant compound between junction boxes and covers.

(B) Standard Sized Junction Boxes

Provide standard sized junction boxes with minimum inside dimensions of 16"(l) x 10"(w) x 10"(d) that meet or exceed the Tier 15 requirements of ANSI/SCTE 77. Provide certification that testing methods are compliant with ANSI/SCTE 77. Vertical extensions of 6" to 12" shall be available from the junction box manufacturer.

(C) Oversized Heavy-Duty Junction Boxes

Provide oversized heavy-duty junction boxes and covers with minimum inside dimensions of 30"(l) x 15"(w) x 24"(d) that meet or exceed the Tier 15 requirements of ANSI/SCTE 77. Provide certification that testing methods are compliant with ANSI/SCTE 77.

1098-6 WOOD POLES

Use treated wood poles meeting the requirements of Section 1082. Unless otherwise required by the contract, use Class 4 or better wood poles that have a minimum length of 40 feet and are of a sufficient length to maintain the minimum required clearances above the roadway, obstructions, and affected railroad tracks.

1098-7 GUY ASSEMBLIES

Furnish guy assemblies with anchor assemblies, guy cable, and guy cable guard.

Provide anchor assemblies with all miscellaneous hardware consisting of either expanding anchor with rod and tripleye attachment, screw anchor with extension rod and tripleye attachment, or expanding rock anchor with tripleye attachment. Ensure anchor assembly size is adequate for site conditions. Provide rods constructed of hot-dipped galvanized steel sized according to the soil bearing conditions in the area. Provide tripleye guy attachments constructed of hot-dipped galvanized steel. Anchor assemblies with double-strand eyes may be used in lieu of those with the tripleye feature when only one guy cable is to be attached. Ensure anchor assemblies are 7 feet minimum in length.

For type of anchor assembly furnished, ensure the following:

(A) **Expanding anchor** - provide steel construction with protective paint or heat shrink of 6 mil plastic to protect metal during shipping and storage.

(**B)** **Screw anchor** - provide hot-dipped galvanized steel construction.

(C) **Expanding rock anchors** - provide malleable iron and rust-resisting paint construction.

Provide 3-bolt clamp fabricated from galvanized steel with minimum length of 5 3/4”. Ensure clamp has parallel grooves (one on each side of bolt holes) for cable placement. Provide three 1/2” diameter galvanized bolts and nuts to tighten the clamp around the messenger cable. Ensure clamp fits 1/4” to 3/8” messenger cable.

Provide full round guy cable guards that are 8 feet in length and constructed of ultraviolet stabilized, high impact, bright yellow, high density polyethylene.

Provide guy cables consisting of messenger cable of the same size as the largest sized messenger cable to be guyed. Comply with Article 1098-3 Messenger Cable.

1098-8 INDUCTIVE DETECTION LOOPS

(A) Loop Sealant

Provide loop slot sealant that completely encapsulates loop wire when installed according to manufacturer’s instructions. Provide loop sealant that does not generate temperatures greater than 220 degrees F. Ensure sealant bonds with asphalt and concrete pavement saw slots so sealant and encapsulated loop wire do not come out of slot. Ensure sealant is self-leveling, but with sufficient viscosity to prevent exit from saw slot when installed along a ten percent grade.

Provide sealant that protects loop wire by preventing the entrance of dirt, water, rocks, sticks, and other debris into saw slot, and is resistant to traffic, water, gasoline, chemical and chemical fumes, mild alkalis, oils, and mild acids. Ensure sealant will

not be affected by water and sealant does not chemically interact with pavement and loop wire insulation.

Ensure loop sealant has sufficient flexibility to permit expected pavement expansion and contraction due to weather and to permit pavement movement due to traffic without cracking for a temperature range of -40 to 160 degrees F.

Provide sealant with a usable life of at least ten minutes once mixed, when the ambient temperature is 75 degrees F. Ensure sealant dries to tack free state in less than two hours, and does not flow within or out of saw slot after exposed surface has become tack free. Tack free time will be determined by testing with a cotton ball until no sealant adheres to cotton ball and no cotton adheres to sealant.

Ensure two part sealant cures within 48 hours to attain 95 percent of published properties for the cured material.

Ensure one part sealant cures within 30 days to attain 95 percent of published properties for the cured material.

(B) Loop Wire

Provide loop wire composed of 19-strand conductor insulated by a cross-linked polyethylene compound. Ensure insulated conductors are completely encased in tubes of low density polyethylene compound. Print manufacturer's name, manufacture year, and any applicable part number on encasing tube at intervals of 2 feet or less.

Provide number 14 AWG copper conductors fabricated from 19 strands that comply with ASTM B 3 before insulating. Ensure stranded conductors use either concentric or bunch stranding, and comply with circular mil area and physical requirements of ASTM B 8 or ASTM B 174 for bunch stranding.

Provide insulating compound that is cross-linked thermosetting black polyethylene (ASTM D 2655). Ensure insulation is applied concentrically about conductor. Provide insulation thickness not less than 0.026" at any point and minimum average thickness of 0.030" as measured by UL Standard 62.

Ensure insulation of finished conductor will withstand application of a 60 Hertz or 3000 Hertz, 7500 volt (RMS) essentially sinusoidal spark test potential as specified in UL Standard 83.

Provide insulated conductors that are factory-installed in protective encasing tube that comply with the following:

Encasing tube fabricated of polyethylene compound conforming to ASTM D 1248 for Type I, Class C, Grade E5.

Minimum inside diameter of 0.150"
Wall thickness of 0.040" $\pm$ 0.010"
Outside diameter of 0.240" $\pm$ 0.010"

(C) Conduit

Comply with Article 1098-4 for non-metallic conduit.

1098-9 LOOP LEAD-IN CABLE

Furnish lead-in cable with conductors of number 18 AWG fabricated from stranded copper that complies with IMSA Specification 50-2 except as follows:

Provide two pair (4 conductor) insulation pair colors: clear-brown and blue-pink.

Provide four pair (8 conductor) insulation pair colors: clear-brown, blue-pink, clear with black stripe tracer-brown with black stripe tracer, and blue with black stripe tracer-pink with black stripe tracer. Apply continuous stripe tracer on conductor insulation with longitudinal or spiral pattern.

Ensure one spirally-wrapped Aluminum Mylar tape is applied with aluminum side out to completely cover conductor assembly.

Provide cable jacket formed from black polyethylene. Ensure finished jacket provides environmental stress resistance, outdoor weatherability, toughness, low temperature performance, and ultraviolet resistance.

Provide a ripcord to allow cable jacket to be opened without using a cutter.

Provide length markings in sequential feet and within one percent of actual cable length. Ensure character height of the markings is approximately 0.10".

1098-10 FIBER-OPTIC CABLE

(A) SMFO Communications Cable

Furnish loose tube fiber-optic cable with required fiber count that complies with RUS CFR 1755.900, single mode with dielectric central member. Use single mode fiber in cable that does not exceed attenuation of 0.25 dB/km at 1550 nm and 0.35 dB/km at 1310 nm. Provide cable with all fibers that are useable and with surface sufficiently free of imperfections and inclusions to meet optical, mechanical, and environmental requirements. Provide cable with minimum of one ripcord under sheath for easy sheath removal and with shipping, storage, installation, and operating temperature of at least -40 to 160 degrees F with a dual layered, UV cured acrylate fiber coating applied by cable manufacturer that may be stripped mechanically or chemically without damaging fiber.

Provide fibers inside loose buffer tube. Use doped silica core surrounded by concentric silica cladding for each fiber. Distinguish each fiber and buffer tube from others by means of color coding that meets EIA/TIA-598 *Color Coding of Fiber-Optic Cables*. In buffer tubes containing multiple fibers, ensure colors are stable during temperature cycling and not subject to fading, sticking, or smearing into each other or into gel filling material. Use fillers in cable core if necessary to provide a symmetrical cross-section of cable. Fill buffer tubes with non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. Ensure gel is free from dirt and foreign matter, and is removable with conventional nontoxic solvents.

Provide a central member consisting of a dielectric glass reinforced plastic rod. Apply binders with sufficient tension to secure buffer tubes and binders to the central member without crushing buffer tubes. Ensure that binders are non-hygroscopic, non-wicking (or rendered so by the flooding compound), and dielectric with low shrinkage.

Provide cable that has cable core interstices filled with super-absorbent, water-blocking compound that is non-conductive and homogenous. Ensure compound is free from dirt and foreign matter, and is removable with conventional nontoxic solvents.

Provide cable with high tensile strength aramid yarns or fiberglass yarns that are helically stranded evenly around cable core.

Provide cable jacket of consistent thickness that is free of holes, splits, and blisters, and contains no metal elements. Provide outer jacket of medium density polyethylene with minimum nominal sheath thickness of 0.050 inch. Ensure polyethylene contains carbon black for ultraviolet light protection and does not promote fungus growth.

Provide length markings in sequential feet and within one percent of actual cable length. Ensure character height of the markings is approximately 0.10".

(B) Drop Cable

Furnish drop cable assemblies to provide communications links between splice enclosures and transceivers through interconnect centers. Furnish drop cable assemblies containing a minimum of six individual fibers.

Furnish drop cable assemblies that comply with RUS-CFR 1755.900. Ensure drop cable assemblies have the same operating characteristics as the SMFO cable it is to be coupled with.

On one end of cable assemblies, furnish six ST-PC connectors for termination on connector panel in equipment cabinet. Provide either factory assembled drop cables with ST-PC connectors or field installed connectors.

Ensure attenuation of drop cable at 1310 nm does not exceed 0.5 dB/km. Ensure attenuation loss for complete drop cable assembly does not exceed a mean value of 1.5 dB.

Provide length markings in sequential feet and within one percent of actual cable length. Ensure character height of markings is approximately 0.10".

(C) Communications Cable Identification Markers

Furnish yellow communications cable identification markers that are resistant to fading when exposed to UV sources and changes in weather. Use markers designed to coil around fiber-optic cable that do not slide or move along the surface of the cable once installed. Ensure exposure to UV light and weather does not affect the markers natural coiling effect or deteriorate performance. Provide communications cable wraps that permit writing with an indelible marking pen and contain the following text in black:

WARNING
NCDOT FIBER OPTIC CABLE
CONTACT TELEPHONE NUMBER: _____
WARNING
NCDOT FIBER OPTIC CABLE

Overall Marker Dimensions: 7"(l) x 4"(w)
Lettering Height: 3/8 inch for *WARNING,* 1/4" for all other lettering

Submit a sample of proposed communications cable identification markers to the Engineer for approval before installation.

(D) Fiber-Optic Cable Storage Guides

Furnish fiber-optic storage guides (snowshoes) that are non-conductive and resistant to fading when exposed to UV sources and changes in weather. Ensure snowshoes have a captive design such that fiber-optic cable will be supported when installed in the rack and the minimum bending radius will not be violated. Provide stainless steel attachment hardware for securing snowshoes to messenger cable and black UV resistant tie-wraps for securing fiber-optic cable to snowshoe. Ensure snowshoes are stackable so that multiple cable configurations are possible.

1098-11 FIBER-OPTIC SPLICE CENTERS

(A) Interconnect Center

Furnish compact, modular interconnect centers designed to mount inside equipment cabinets. Design and size interconnect centers to accommodate all fibers entering cabinets.

Provide splice trays that hold, protect, and organize optical fibers, and secure fibers inside splice tray. Design and size splice trays to be dielectric, to accommodate all fibers entering splice tray, and to provide sufficient space to prevent microbending of optical fibers. Provide connector panels with ST-type connectors.

Furnish SMFO pigtails with each interconnect center. Provide pigtails containing connector panels that are a maximum of 6 feet in length with a factory assembled PC-ST connector on one end. Ensure SMFO pigtails meet the operating characteristics of the SMFO cable with which it is to be coupled.

Furnish SMFO jumpers that are a minimum of 3 feet in length with factory assembled PC-ST connectors on each end. Ensure SMFO jumpers meet the operating characteristics of the SMFO cable with which it is to be coupled.

(B) Splice Enclosure

Furnish splice enclosures that are re-enterable using a mechanical dome-to-base seal with a flash test valve, and are impervious to the entry of foreign material (water, dust, etc.). Ensure enclosures are manufactured in such a manner to be suitable for aerial, pedestal, buried, junction box, and manhole installation.

Provide enclosures with a minimum of one over-sized oval port that will accept two cables and with a minimum of four round ports (for single cables) that will accommodate all cables entering enclosure. Provide heat shrink cable shields with enclosure to ensure weather tight seal where each cable enters enclosure.

Within enclosures, provide enough hinged mountable splice trays to store the number of splices required, plus the capacity to house six additional splices. Provide a fiber containment basket for storage of loose buffer tubes expressed through the enclosure. Ensure enclosures allow sufficient space to prevent microbending of buffer tubes when coiled.

Provide splice trays that hold, protect, and organize optical fibers, and secure fibers inside splice tray. Provide splice trays that are dielectric.

1098-12 FIBER-OPTIC TRANSCEIVERS

Furnish shelf-mounted, modular, single mode fiber-optic transceivers that transmit and receive optical signals over a fiber-optic communications medium of two fibers and interface with equipment cabinets (signal controller, dynamic message signs, etc.). Ensure transceivers are asynchronous in operation. Ensure transceivers are capable of operating up to 5 miles without boosting signal and without distortion. Ensure transceivers are switch selectable for either local or master operation.

Do not provide transceivers internal to system equipment. Provide identical transceivers at all locations capable of being interchanged throughout system.

Provide LEDs on the front panel of transceivers for power, and transmitting and receiving indications. Comply with the following:

Input Power:	115 VAC
Minimum Loss Budget:	12 dB with corresponding receiver
Operating Wavelength:	1310 or 1550 nm
Optical Connector:	ST
Signal Connector:	Female Plug Type
Temperature Range:	0 to 150 degrees F

Ensure modems operate in one of the following topologies:

Drop and Repeat Transceivers: Furnish transceivers that transmit and receive data in drop-and-repeat poll-response data network mode with EIA/TIA-232, EIA/TIA-422, and EIA/TIA-485 protocols.

Self-Healing Ring Transceivers: Furnish transceivers that transmit and receive data in a drop-and-insert poll-response data network mode with EIA/TIA-232, EIA/TIA-422, and EIA/TIA-485 protocols. Ensure transceiver operates in a Self-Healing Ring Network Architecture.

1098-13 DELINEATOR MARKERS

Furnish tubular delineator markers, approximately 6 feet long, and constructed of Type III, high density polyethylene material. Provide delineator assemblies that are ultraviolet stabilized to help prevent components from color fading, warping, absorbing water, and deterioration with prolonged exposure to the elements. Provide delineators

designed to self-erect after being knocked down or pushed over. Provide orange delineator posts.

Provide text, including division contact number, hot stamped in black on a yellow reflective background material that will not fade or deteriorate over time. Provide delineator markers with nominal message height of 15" that contain the following text visible from all directions approaching the assembly:

WARNING	**FIBER OPTIC CABLES**
BEFORE EXCAVATING OR IN AN EMERGENCY CALL (___) ___-____	
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION	

1098-14 PEDESTALS

Provide aluminum pedestals with foundations that conform to AASHTO. Furnish Class B minimum concrete that conforms to the applicable parts of Section 1000 Portland Cement Concrete Production and Delivery.

Provide reinforcing steel that conforms to the applicable parts of Section 1070 Reinforcing Steel.

Provide caps and bases as part of pedestal assemblies. Unless otherwise required, furnish pedestals that provide the following heights:

To support traffic signal equipment cabinets – 30" above foundation.

To support signal heads, see Section 1705 for required signal head height.

Provide pedestal caps fabricated from cast aluminum that meets Aluminum Association Alloy 356.0F. Provide stainless steel set screws as fasteners.

Provide either shoe-type or transformer-type pedestal bases made of aluminum that meets Aluminum Association Alloy 356.0 or equivalent, and designed to break upon impact in accordance with AASHTO requirements. For shoe-type bases, provide aluminum flange plate with four anchor boltholes, a hole to match the shaft, and a 4 x 8" hand hole with a reinforced frame located 8" above base. For transformer-type bases, provide overall dimensions of 15"(l) x 13"(w) x 13"(d) and an 8" x 8" hand hole with removable cover.

Ensure bases are continuously welded to shafts or threaded to receive shafts. For use in grounding, provide a 1/2" minimum diameter, coarse thread stud located inside base at the handhold and oriented for easy access.

For each pedestal, provide four bolts with outside diameter of 3/4" and length of 18" each with leveling nut and washer. Ensure anchor bolts are hot-dipped galvanized in accordance with ASTM A 153 with completely galvanized nuts and washers.

1098-15 SIGNAL CABINET FOUNDATIONS

Provide foundations with a minimum pad area that extends 24" from front and back of cabinet and 3" from sides of cabinet.

Furnish cabinet foundations with chamfered top edges. Provide minimum Class B concrete.

Provide preformed cabinet pad foundations with 7"(l) x 18"(w) minimum opening for the entrance of conduits. Ensure that no more than four 3/4" holes are cast or drilled in each pad.

1098-16 CABINET BASE ADAPTER/EXTENDER

Fabricate base adapters and extenders from the same materials and with the same finish as cabinet housing. Fabricate base adapter and extender in the same manner as controller cabinets, meeting all applicable specifications called for in Section 7.5 of CALTRANS TEES (11/19/99). Provide base adapters and extenders a minimum height of 12".

1098-17 BEACON CONTROLLER ASSEMBLIES

(A) General

Furnish all cabinets with a solid state flasher that meets NEMA TS-2-1998. Encapsulate flasher components as necessary. Connect flasher to provide beacon operation as specified.

Submit drawings showing dimensions, location of required equipment and mechanisms, cabinet electrical diagrams, part numbers and descriptions of required equipment and accessories to the Engineer. Provide certification to the Engineer that materials used in cabinet construction meets these Specifications.

Furnish unpainted, natural, aluminum cabinet shells that comply with Section 7 of NEMA TS-2-1998. Ensure all non-aluminum hardware on cabinet is stainless steel or Department approved non-corrosive alternate. Provide roof with slope from front to back at a minimum ratio of 1" drop per 2 feet. Ensure each exterior cabinet plane surface is constructed of a single sheet of seamless aluminum. Ensure all components are arranged for easy access during servicing. When modular in construction, provide guides and positive connection devices to ensure proper pin alignment and connection.

Connect metal oxide varister, type V150LA20, between each field terminal and ground bus.

Provide beacon controller assemblies equipped with terminal blocks (strips) for termination of all field conductors and all internal wires and harness conductors. Terminate all wires at terminals. Ensure all field terminals are readily accessible without removing equipment and located conveniently to wires, cables, and

harnesses to be connected. Ensure terminals are not located on under side of shelves or at other places where they are not readily visible or where they may present a hazard to personnel who might inadvertently touch them. Provide terminal blocks made of electrical grade thermoplastic or thermosetting plastic. Ensure each terminal block is of closed back design and has recessed-screw terminals with molded barriers between terminals. Ensure each terminal consists of two terminal screws with removable shorting bar between them. Ensure each terminal block is labeled with a block designation and each terminal is labeled with a number. Ensure all terminal functions are labeled on terminal blocks. Provide labels that are visible when terminal block is fully wired. Show labels on cabinet wiring diagrams. Ensure terminals serving similar functions are grouped together.

Connect each conductor, including unused conductors, within or entering cabinet to a terminal using crimped spade lugs. Place no more than two conductors on any single terminal screw. Terminations to back panel may be soldered. Do not use quick connectors or barrel connectors. Make all connections at terminals. Do not make in-line splices.

Ensure outgoing circuits have same polarity as line side of power supply. Ensure common return has same polarity as grounded conductor (neutral) of power supply.

Neatly package all wiring. Dress harnesses by lacing, braiding, or tying with nylon tie wraps at closely spaced intervals. Attach wires, cables, or harnesses to cabinet walls for support or to prevent undue wear or flexing. Use nylon tie straps or metal clamps with rubber or neoprene insulators. Screw these attachment devices to cabinet. Do not use stick-on clamps or straps.

Tag AC+, AC-, chassis ground, and flasher circuit conductors with non-fading, permanent sleeve labels at conductor ends at terminals or use color-coded wire. Ensure sleeve labels tightly grip conductors. Alternatively, use hot stamped labels on internal conductor insulation at intervals of no greater than 4". Ensure label legends are permanent.

Ensure all jumpers are wire conductors or metal plates. Do not use printed circuit back panels or back panels using wire tracks as jumpers.

Lay out all equipment and components for ease of use and servicing. Ensure equipment controls can be viewed and operated without moving or removing any equipment. Ensure there is access to equipment or components for servicing without removing any other equipment or components. Removal of equipment is acceptable to access fan or thermostat. Ensure equipment can be removed using only simple hand tools. Ensure layout of equipment and terminals within the various cabinets furnished is identical from cabinet to cabinet, unless otherwise approved.

Mount equipment using harnesses with suitable multipin (or similar) connectors. Design or key all equipment to make it physically impossible to connect unit to wrong connector. Ensure that functionally equivalent equipment is electrically and mechanically interchangeable.

Equip vents with standard-size, replaceable filters or, if located where they can easily be cleaned, permanent filters.

(B) Type F1 Cabinet

Provide dual-circuit flasher and 20-amp circuit breaker. Install one insect-resistant vent on bottom and one on top on opposite wall in order to facilitate airflow.

(C) Type F2 Cabinet

Provide 20" high x 16" wide x 12" deep cabinet, dual-circuit flasher, 20-amp circuit breaker, and solid state time switch. Provide filtered power to time switch. Install one insect-resistant vent on each side of cabinet at the bottom in order to facilitate airflow.

(D) Type F2 and F3 Cabinet – Surge Protection and Documentation

Furnish and install a power line surge protector in the service power. Provide a two-stage power line surge protector that allows connection of the radio frequency interference filter between stages of the device. Ensure device has a maximum continuous current rating of at least 10A at 120 V. Ensure device can withstand a minimum of 20 peak surge current occurrences at 20,000A for an 8x20 microsecond waveform. Provide maximum clamp voltage of 280V at 20,000A with a nominal series inductance of 200μh. Ensure voltage does not exceed 280V. Provide devices that comply with the following:

Frequency (Hz)	Minimum Insertion Loss (dB)
60	0
10,000	30
50,000	55
100,000	50
500,000	50
2,000,000	60
5,000,000	40
10,000,000	20
20,000,000	25

Install surge protector in circuit breaker enclosure in a manner that will permit easy servicing. Ground and electrically bond surge protector to cabinet within 2" of surge protector.

Furnish and install a suitably sized plastic envelope or container in cabinet for holding cabinet wiring diagrams and equipment manuals. Locate envelope or container so it is convenient for service personnel. Furnish 2 sets of non-fading cabinet wiring diagrams in a paper envelope or container and place them in the plastic envelope or container.

(E) Type F3 Cabinet

Provide 25" high x 22" wide x 15" deep] cabinet, dual-circuit flasher, fan and thermostat, and cabinet light.

Install a vent or vents at or near the cabinet bottom to permit the intake of air sized for the rated flow of air from the fan, but no smaller than 20 in^2.

Equip cabinet with two NEMA standard circuit breakers (20A & 15A) installed to ensure personnel servicing the cabinet, including rear of back panel, cannot inadvertently be exposed to a hazard. Install a terminal block that will accommodate service wire as large as number 4 AWG, and connect it to the circuit breaker. Install circuit breakers in addition to any fuses that are a part of the individual control equipment components. Wire cabinet light and thermostatically-controlled fan to the 15A circuit breaker.

Ensure cabinet has sufficient electrical and electronic noise suppression to enable all equipment in it to function properly. In addition, equip cabinet with a radio interference filter connected between stages of the power line surge protector. Ensure filter minimizes interference generated in the cabinet in both broadcast and aircraft frequencies. Use filter that provides attenuation of at least 50 decibels over a frequency range of 200 kilohertz to 75 megahertz. Ensure filter is hermetically sealed in an insulated metal or plastic case. Provide filter designed to operate in a 120-volt, 60 Hertz, single-phase circuit with currents of 15 amperes or more, such as HESCO LF35, or equivalent.

Provide filtered power to detector panel.

DIVISION 11
WORK ZONE TRAFFIC CONTROL

SECTION 1101
WORK ZONE TRAFFIC CONTROL GENERAL REQUIREMENTS

1101-1 TRAFFIC CONTROL PLAN (TCP)

(A) General

Maintain traffic through work zones in accordance with these Specifications, the Traffic Control Plan, the *MUTCD*, and *Roadway Standard Drawings*.

If a conflict arises, Phasing and Drawings govern over project notes, and local notes govern over general notes.

(B) Phasing

Complete the requirements of each Phase before proceeding to the next Phase and the requirements of each Step before proceeding to the next Step, unless the plans permit work to be performed concurrently.

If a Traffic Control Plan Phasing is broken into Areas, work may be performed in more than one areas simultaneously as described in the plan. If a project is divided into Area 1 and Area 2, work can be performed in both Areas simultaneously but shall progress in each Area through the Phase and Step requirements.

(C) Project Notes

Two types of Project Notes may be included in the Traffic Control Plan;

(1) General Notes apply at all times during the project.

(2) Local Notes apply only for the specific times and locations that they are referred to in the phasing and/or detail sheets.

(D) Alternate to Traffic Control Plan

If desired, submit an alternate traffic control plan a minimum of 30 calendar days in advance of the anticipated implementation to allow for adequate review time. Do not implement alternate plans for traffic control until approved in writing and properly sealed. No adjustment in compensation or extension of the completion date(s) will be allowed due to the review time of the alternate. If an alternate traffic control plan is implemented, the Contractor shall be responsible for any unanticipated changes to subsequent Phases and/or Steps.

(E) Traffic Control Plan not fully covered in the Contract

When the Traffic Control Plan does not cover a particular work function, notify the Engineer to allow for the development or modification of a sealed set of the Traffic Control Plans.

1101-2 BLASTING ZONES

When blasting operations are within 1000 feet of a travelway, provide the appropriate traffic control as shown in the plans and/or the *Roadway Standard Drawings*.

1101-3 CONSTRUCTION VEHICLE CROSSINGS

Do not cross a median, ramps, or loops with vehicles and equipment unless a specific location for crossing is approved and required traffic control devices are used as shown in the *Roadway Standard Drawings*.

1001-4 ON-ROAD CONSTRUCTION VEHICLES

When operating outside of a closed lane or haul road crossing in a work zone, on-road construction vehicles are subject to the North Carolina Division of Motor Vehicle weight and safety regulations as commercial vehicles.

1101-5 EXCAVATIONS WITHIN TRAVELWAY

During the process of excavating in a travelway where traffic is to be later maintained, make provisions to backfill and repair any excavated or damaged pavement before allowing traffic to proceed over the affected lanes. In low speed areas (35 MPH or less) metal plates may be used to cover excavated areas.

1101-6 HAULING OPERATIONS

Comply with the Multiple and Single Vehicle Hauling restrictions as shown in the plans when performing hauling of equipment or materials to or from the project.

Multiple vehicle hauling is defined as the hauling of equipment or materials to or from the project with delivery at intervals of less than five minutes and/or results in more than one vehicle at a particular work site at one time.

Single vehicle hauling is defined as the hauling of equipment or materials to or from the project with delivery at intervals of more than five minutes and results in no more than one vehicle at a particular work site at one time.

1101-7 MATERIAL AND EQUIPMENT STORAGE AND PARKING

When work is not in progress, keep all personnel, equipment, machinery, tools, construction debris and supplies at least 40 feet away from active travel lanes. When vehicles, equipment, and materials are protected by concrete barrier or guardrail, they should be offset a minimum of 5 feet from the barrier or guardrail.

1101-8 PARKING OF PERSONAL VEHICLES

Provide staging areas for personal vehicle parking that is a safe distance (40 feet minimum) from open travel lanes except on freeway facilities. Have staging areas for parking personal vehicles on freeway facilities approved by the Engineer prior to use.

1101-9 PROTECTION OF HAZARDS

Mark all hazards with signs, barricades, drums, or other warning devices.

At each location where work is started which creates a safety hazard, continue the work until completed to the extent that the safety hazard is eliminated. If the work is not pursued

in a continuous manner the Engineer will not allow any other work on the project to be performed until the existing safety hazard is eliminated.

1101-10 TEMPORARY LANE CLOSURES

(A) General

Operate all equipment and personnel within the designated work area during lane closures. Do not impede or stop traffic for the purpose of performing construction related work on the traffic side of the lane closure, except when called for in the Traffic Control Plan.

Install lane closures with the traffic flow, beginning with devices on the upstream side of traffic. Remove lane closures against the traffic flow, beginning with devices on the downstream side of traffic.

Vehicles used to install or remove lane closures shall have flashing or rotating beacons.

(B) Intersections

When construction proceeds through an intersection, provide flagger(s) and all other necessary Traffic Control as required by the plans to direct the traffic through the intersection. When an intersection is signalized, have authorized personnel place the signal in flash mode prior to beginning work in the intersection.

1101-11 TEMPORARY ROAD CLOSURES

(A) Traffic Pattern Alterations

Notify the Engineer 21 calendar days, or as specified, prior to altering the existing traffic pattern.

Pre-plan all traffic pattern alterations. Meet with the Engineer to discuss the implementation strategy before altering traffic. The Engineer will then notify the proper authorities and other affected parties as necessary.

(B) Detour

Ensure that all required detour signing and delineation, including work done by others, are in place prior to placing traffic onto a detour.

(C) Traffic Stoppage

Limit the stoppage of traffic to times specified in the plans. Provide enough time between consecutive stoppages to allow the traffic queue to deplete.

1101-12 TRAFFIC CONTROL SUPERVISION

Designate a Traffic Control Supervisor for the project who is knowledgeable of Traffic Control Plan design, devices and application, and has full authority to insure traffic is maintained in accordance with the contract. Coordinate with Department's project traffic control representative on all details concerning the Contractor's traffic control program.

Provide a Traffic Control Supervisor or designated representative to be on call at all times to make any necessary changes in the traffic control operations in a timely manner.

Coordinate with and cooperate with traffic control supervisors of adjacent or overlapping construction projects to insure safe and adequate traffic control is maintained throughout the projects at all times including periods of construction inactivity.

1101-13 VEHICULAR ACCESS

Maintain continuous and safe vehicular access, including but not limited to, all residences, businesses, schools, police and fire stations, hydrants, other emergency services, hospitals and mailboxes. Conduct operations in such a manner as to limit the inconvenience to property owners.

SECTION 1105
WORK ZONE TRAFFIC CONTROL DEVICES

1105-1 DESCRIPTION

Furnish, install, maintain, relocate, and remove traffic control devices in accordance with the plans and Specifications. All traffic control devices furnished by the Contractor will remain the property of the Contractor, unless otherwise specified in the contract.

1105-2 MATERIALS

Refer to Division 10.

Supply certifications that meet the requirements of Article 106-3, at least 72 hours prior to use for all used traffic control devices.

Provide traffic control devices that are listed on the Department's approved product list or accepted as traffic-qualified by the Work Zone Traffic Control Unit.

1105-3 CONSTRUCTION METHODS

Have all traffic control devices inspected and approved prior to using them on the project.

Install traffic control devices before construction operations begin and during the proper phase of construction. Maintain and relocate traffic control devices during the time they are in use. Keep these devices in place as long as they are needed and immediately remove thereafter. When operations are performed in stages, install only those devices that apply to the present conditions.

1105-4 MAINTENANCE AND INSPECTION

Submit a proposed traffic control device maintenance schedule and checklist for approval prior to construction. Perform continuous maintenance and scheduled inspections of traffic control devices. Review and maintain all traffic handling measures to ensure that adequate provisions are in place for the safety of the public and workers.

Maintenance activities include cleaning of dirty devices or repair or replacement of traffic control devices that are damaged (torn, crushed, discolored), displaced by traffic or other means, or deteriorated beyond effectiveness.

If there are traffic control devices in use, perform inspection on a daily basis.

The name and telephone number of the agency, contractor or supplier may be shown on the non-retroreflective surface of all channelizing devices. Use letters and numbers that are a non-reflective color and not over 2 inches in height.

1105-5 FAILURE TO MAINTAIN TRAFFIC CONTROL

Failure to maintain traffic control measures and traffic control devices in accordance with this Specification may result in formal notification of noncompliance. Implement remedial action immediately for imminent danger situations as directed. Implement remedial action within 48 hours after notification of a safety issue that is not an imminent danger situation. (See Articles 107-22 and 108-7)

Failure to comply may result in having the work performed with available forces and equipment. The Contractor is held responsible for this work, and the actual cost of performing said work will be deducted from the moneys due the Contractor on the contract. In cases of willful disregard for the safety of the public, the Engineer may proceed immediately to implement the measures necessary to provide the appropriate level of traffic control to ensure that the safety of all concerned parties is maintained.

1105-6 MEASUREMENT AND PAYMENT

Payment at the contract unit prices for the various items in the contract will be full compensation for all work covered by this Specification.

SECTION 1110
WORK ZONE SIGNS

1110-1 DESCRIPTION

Furnish, install, maintain, temporarily cover and uncover signs, relocate, and remove work zone signs (stationary) and work zone signs (barricade mounted) in accordance with the contract.

Furnish, install, maintain and relocate portable work zone signs and portable work zone sign stands in accordance with the plans and Specifications. When portable work zone signs and portable work zone sign stands are not in use for periods longer than 30 minutes, collapse or remove sign stands and reinstall once work begins again.

Use portable work zone signs only with portable work zone sign stands specifically designed for one another. Portable work zone signs may be roll up or approved composite signs.

1110-2 MATERIALS

(A) General

Refer to Division 10:

Item	Section
Work Zone Signs	1089-1
Work Zone Sign Supports	1089-2
Barricade Mounted Signs	1089-3

(B) Material Qualifications

Provide portable work zone sign stands, portable signs and sheeting that meet the requirements of NCHRP 350 for Category II traffic control devices and are listed on the Department's approved product list and accepted as traffic-qualified by the Work Zone Traffic Control Unit.

Provide portable work zone signs and stands that are crash tested by the manufacturer. The portable work zone sign and the portable work zone sign stand shall be crash tested together as a system.

(C) Historical Performance

Historical performance of the portable work zone sign and the portable work zone sign stand will help determine the future use of the material by the Department, even if the portable work zone sign or portable work zone sign stand has been traffic-qualified. Poor past or poor current performance of portable work zone signs and/or portable work zone sign stands at any site, whether or not related to a specific contract, may be grounds for non-acceptance of a product on any project under contract.

1110-3 CONSTRUCTION METHODS

(A) Work Zone Signs (stationary)

Install work zone signs (stationary) to stand within 2° of plumb in all directions and under all conditions. Erect signs per Roadway Standard Drawing No. 1110.01 sheet 1 of 1.

Splicing of work zone sign (stationary) posts is acceptable. Splice work zone sign (stationary) posts according to Roadway Standard Drawing No. 1110.01 sheet 1 of 1. Remove entire post when removing signs with spliced posts. Do not back brace work zone sign (stationary) supports.

When required, cover work zone signs with an opaque material that prevents reading of the sign at night by a driver using high beam headlights. Use material that does not damage the sign sheeting.

Any damage incurred from the covering of work zone signs will be determined using Article 901-4. Replace or repair any damaged signs due to the covering at no expense to the Department.

Field conditions may from time to time dictate that splice, minimum embedment, lateral clearance and/or edge of pavement elevation for stationary work zone signs may not be achievable using equipment and methods standard to normal industry practices. See the *NCDOT Construction Manual* for examples for alternative solutions.

(B) Work Zone Signs (Barricade Mounted)

Mount approved composite or roll up signs to barricade rails so that the signs do not cover more than 50 percent of the top two rails or 33 percent of the total area of the three rails. Signs shall be mounted a minimum of 1 foot from the ground to the bottom of the sign.

(C) Work Zone Signs (Portable)

(1) General

Install the portable work zone sign and sign stand to stand plumb within 10° left and right, within 20° front and back and be capable of standing erect in windy conditions.

When not in use for periods longer than 30 minutes, lay the portable work zone sign flat on the ground and collapse the sign stand and lay it flat on the ground.

Clean the sign face prior to use.

(2) Work Zone Sign (Portable)

Install portable work zone sign stands to carry roll up or approved composite signs at a minimum height of 1 foot from the bottom of the sign to the edge of pavement elevation on two-lane two-way roadways and at least 5 feet from the bottom of the sign to the edge of pavement elevation on multi-lane roadways.

1110-4 MEASUREMENT AND PAYMENT

Nominal dimensions will be used to compute the sign panel areas

Work Zone Signs (Stationary) will be measured and paid for as the actual number of square feet that have been satisfactorily installed at each location and accepted by the Engineer. Where a particular sign is used at more than one location, measurement will be made at each location.

Work Zone Signs (Barricade Mounted) will be measured and paid for as the actual number of square feet that have been satisfactorily installed on barricades and accepted by the Engineer. Payment will be made for the initial installation only. Relocation of signs will be considered incidental to the measurement of the quantity of signs.

Work Zone Signs (Portable) will be measured and paid for as the actual number of square feet that have been satisfactorily installed and accepted by the Engineer. Payment

will be made for the initial installation only. Relocation of signs will be considered incidental to the measurement of the quantity of signs.

No direct payment will be made for stationary work zone sign supports or portable work zone sign stands. All stationary work zone sign supports or portable work zone sign stands are considered incidental to the work of providing work zone signs.

Payment will be made under:

Pay Item	Pay Unit
Work Zones Signs (Stationary)	Square Foot
Work Zones Signs (Barricade Mounted)	Square Foot
Work Zones Signs (Portable)	Square Foot

SECTION 1115
FLASHING ARROW PANELS, TYPE C

1115-1 DESCRIPTION

Furnish, install, place, operate, maintain, relocate, and remove flashing arrow panels in accordance with the contract.

1115-2 MATERIALS

(A) General

Refer to Division 10:

Item	Section
Flashing Arrow Panels	1089-6

(B) Material Qualifications

Use Flashing Arrow Panels that have been evaluated by NTPEP.

Use Flashing Arrow Panels that are on the Department's Approved Products List and are traffic-qualified by the Work Zone Traffic Control Unit.

(C) Historical Performance

Historical performance of the Flashing Arrow Panels will help determine the future use of the material by the Department, even if the Flashing Arrow Panel has been traffic-qualified. Poor past or poor current performance of Flashing Arrow Panels at any site, whether or not related to a specific contract, may be grounds for non-acceptance of a product on any project under contract.

1115-3 CONSTRUCTION METHODS

Use arrow panels that have the capability to display mode selections.

Do not use straight-line caution or chevron displays.

Mount flashing arrow panels on trucks, trailers, or other mobile units.

1115-4 MEASUREMENT AND PAYMENT

Flashing Arrow Panels, Type C will be measured and paid for as the maximum number of panels that have been satisfactorily placed and accepted by the Engineer in use at any one time during the life of the project as required by the contract.

Payment will be made under:

Pay Item	Pay Unit
Flashing Arrow Panel, Type C	Each

SECTION 1120
CHANGEABLE MESSAGE SIGNS

1120-1 DESCRIPTION

Furnish, install, maintain, relocate and remove changeable message signs in accordance with the contract.

1120-2 MATERIALS

(A) General

Refer to Division 10:

Item	Section
Changeable Message Signs	1089-7

(B) Material Qualifications

Use Changeable Message Signs that have been evaluated by NTPEP.

Use Changeable Message Signs that are on the Department's Approved Products List and are traffic-qualified by the Work Zone Traffic Control Unit.

(C) Historical Performance

Historical performance of the Changeable Message Signs will help determine the future use of the material by the Department, even if the Changeable Message Sign has been traffic-qualified. Poor past or poor current performance of Changeable Message Signs at any site, whether or not related to a specific contract, may be grounds for non-acceptance of a product on any project under contract.

1120-3 CONSTRUCTION METHODS

Mount all changeable message signs on a trailer, or truck, as specified in the plans, designed to adequately support the message board in a level position. Align and sight the changeable message sign to provide optimal driver visibility. Sign operator will adjust flash rate so that a minimum of two complete sign panels can be displayed and legible to a driver while approaching the sign at the posted speed.

Relocate the units for the various stages of construction as shown in the plans or as needed to adequately inform the motorists.

Provide an experienced operator for the changeable message sign during periods of operation to ensure that the messages displayed on the sign panel are in accordance with the plans and in accordance with message content guidelines. Ensure that the message sign is illuminated properly to meet the existing light conditions, and that all adjustments for operation of the sign are made as needed to properly guide motorists.

Expedite repairs due to failure, malfunction, or damage to a changeable message sign. Furnish another changeable message sign (approved by the Engineer and at no additional cost) during the repair time. Repair and/or replace changeable message sign immediately; otherwise, suspend all construction activities requiring the use of the sign until the sign is restored to operation.

1120-4 MAINTENANCE

Perform all maintenance operations recommended by the manufacturer of the sign. Include the periodic cleaning of the sign face and associated solar panels in maintenance operations.

1120-5 MEASUREMENT AND PAYMENT

Changeable Message Signs will be measured and paid for as the maximum number of changeable message signs acceptably placed and in operation, at any one time during the life of the project. Payment for Changeable Message Signs will be made on the following schedule:

70% of the unit bid upon placing the unit in service.
20% of the unit bid when the project is 50% complete.
10% of the unit bid when the project is 100% complete.

Changeable Message Signs (Short Term) will be measured and paid for as the actual number of days the changeable message sign (short term) is used on a project for a specific work operation, removed from the project after the specific operation is complete, and that remains in use on the project no longer than 1 month.

Payment will be made under:

Pay Item	Pay Unit
Changeable Message Sign	Each
Changeable Message Sign (Short Term)	Per Day

SECTION 1130
DRUMS

1130-1 DESCRIPTION

Furnish, install, maintain, relocate, and remove drums with ballast in accordance with the contract.

1130-2 MATERIALS

Refer to Division 10

Item	Section
Drums	1089-5

Provide drums that are on the Department's Approved Products List and are traffic-qualified by the Work Zone Traffic Control Unit.

1130-3 CONSTRUCTION METHODS

Utilize the same type of reflective sheeting on all drums installed at any one time during the life of the project.

Use a ballasting method in accordance with manufacturer's specification. When using a tire ballasting method, use approved manufacturer's tires and place the tires flush with the ground.

1130-4 MAINTENANCE

At no cost to the Department, immediately replace any drum, ballast, or reflective sheeting that are torn, crushed, discolored, or otherwise damaged.

1130-4 MEASUREMENT AND PAYMENT

Drums will be measured and paid for as the maximum number of drums acceptably placed and in use at any one time during the life of the project.

Relocation of drums is considered incidental to the measurement of the quantity of drums and no separate payment will be made.

Payment will be made under:

Pay Item	Pay Unit
Drums	Each

SECTION 1135
CONES

1135-1 DESCRIPTION

Furnish, install, relocate, maintain, and remove cones and reflective cone collars in accordance with the contract.

1135-2 MATERIALS

Refer to Division 10:

Item	Section
Cones	1089-5

Provide cones that are on the Department's Approved Products List or are traffic-qualified by the Work Zone Traffic Control Unit.

1135-3 CONSTRUCTION METHODS

Use reflective collars on all cones used between dusk and dawn. Use the same type of reflective sheeting on all cone collars installed at any one time during the life of the project. Do not use cones in the upstream taper of lane or shoulder closures for multilane roadways and for no longer than 3 consecutive days.

1135-4 MAINTENANCE

At no cost to the Department, immediately replace any cone or reflective collar that is torn, crushed, discolored, or otherwise damaged.

1135-5 MEASUREMENT AND PAYMENT

Cones will be measured and paid for as the maximum number of cones acceptably placed and in use at any one time during the life of the project.

Relocation of cones is considered incidental to the measurement of the quantity of cones and no separate payment will be made.

Payment will be made under:

Pay Item	Pay Unit
Cones	Each

SECTION 1145
BARRICADES

1145-1 DESCRIPTION

Furnish, erect, maintain, relocate, ballast, and remove barricades in accordance with the contract.

1145-2 MATERIALS

Refer to Division 10:

Item	Section
Barricades	1089-3

Provide barricades that meet the requirements of NCHRP 350 for Category II traffic control devices and are on the Department's Approved Products List and are traffic-qualified by the Work Zone Traffic Control Unit.

1145-3 CONSTRUCTION METHODS

At the end of the workday, properly close the road where construction equipment accesses a road closure through Type III barricades.

Use sandbags or other approved ballasting methods to prevent overturning of barricades by the wind. If needed, place sandbags or other acceptable ballasting on the feet of the frame. Do not ballast barricades with objects such as rocks or chunks of concrete.

Do not anchor barricades to any pavement surfaces unless such anchoring method has passed the crash test requirement of NCHRP 350 for work zone category II devices.

Point the striped diagonals on the barricade rails in the direction traffic is being directed.

1145-4 MAINTENANCE

At no cost to the Department, periodically inspect barricades and ballast. Replace any ballast as needed, including sandbags that have loose sand outside the bag.

1145-5 MEASUREMENT AND PAYMENT

Barricades (Type III) will be measured and paid for as the maximum number of linear feet of barricades acceptably placed and in use at any one time during the life of the project. Measurement will be made of the total length of each barricade along one rail.

Relocation of barricades is considered incidental to the measurement of the quantity of barricades.

Payment will be made under:

Pay Item	Pay Unit
Barricades (Type III)	Linear Foot

SECTION 1150
FLAGGERS

1150-1 DESCRIPTION

Furnish, relocate, and maintain the flaggers, hats, vests and STOP/SLOW Paddles and any other incidentals necessary to complete the work in accordance with the contract.

1150-2 MATERIALS

Refer to Division 10:

Item	Section
Flaggers	1089-12

1150-3 CONSTRUCTION METHODS

Provide the services of competent and properly equipped flagger(s) (see Roadway Standard Drawing No. 1150.01) at locations and times for such periods as necessary for the control and protection of vehicular and pedestrian traffic. Use flagging methods that comply with the guidelines in the MUTCD.

Flagging operations are not allowed for the convenience of the Contractor's operations. However, if safety issues exist (i.e. sight/stopping site distance), the Engineer may approve the use of flagging operations.

1150-4 MEASUREMENT AND PAYMENT

The Department will pay for all flaggers, including those used at -Y- lines, that are used in conjunction with a lane closure. Flaggers used for operations not involving a lane closure will be considered incidental to that operation and no payment will be made.

Flaggers (day) will be measured and paid for as the actual number of days that each flagger is satisfactorily provided and accepted by the Engineer during the life of the project. On any calendar day that more than one flagger is used, the quantity to be paid for on that calendar day will be the maximum number of flaggers used at one time in that calendar day.

Any flagger (Days) used for less than one hour will be considered incidental to that operation.

Flaggers (hour) will be measured and paid for as the actual number of hours that each flagger is satisfactorily provided and accepted by the Engineer during the life of the project.

Payment will be made under:

Pay Item	Pay Unit
Flaggers	Day
Flaggers	Hour

SECTION 1160
TEMPORARY CRASH CUSHIONS

1160-1 DESCRIPTION

Furnish, install, maintain, reset, and remove temporary crash cushions in accordance with the contract.

1160-2 MATERIALS

(A) General:

Refer to Division 10:

Item	Section
Temporary Crash Cushions	1089-8

(B) Material Qualifications

Use Temporary Crash Cushions that meet the requirements of NCHRP 350 Test Level II or III for work zone traffic control devices and are on the Department's Approved Products List and are traffic-qualified by the Work Zone Traffic Control Unit.

(C) Historical Performance

Historical performance of the Temporary Crash Cushions will help determine the future use of the material by the Department, even if the Temporary Crash Cushion has been traffic-qualified. Poor past or poor current performance of Temporary

Crash Cushions at any site, whether or not related to a specific contract, may be grounds for non-acceptance of a product on any project under contract.

1160-3 CONSTRUCTION METHODS

Prior to use, furnish the Engineer detailed brochures, specifications, and other manufacturer's data that completely describes the performance criteria, installation, and instructions for the crash cushion. Ensure that the crash cushion is rated for at least the same speed as the facility on which it will be used.

The Contractor may provide a portable base for installation. When a portable base is used, provide one that is designed and/or approved by the manufacturer of the temporary crash cushion.

Install temporary crash cushions in accordance with the manufacturer's specifications.

Use temporary crash cushions that have a yellow reflective end treatment to delineate the approach end of the crash cushion to oncoming traffic.

Repair any pavement damaged by the installation or removal of a temporary crash cushion at no cost to the Department.

1160-4 MAINTENANCE

Repair or replace within 24 hours any temporary crash cushion that becomes crushed or otherwise damaged to the point that it will not perform its intended purpose. Suspend all construction activities until the temporary crash cushion is repaired or replaced. Provide safe control of traffic until the temporary crash cushion has been repaired or replaced using approved methods.

1160-5 MEASUREMENT AND PAYMENT

Temporary Crash Cushions will be measured and paid for as the actual number of crash cushions that have been furnished, satisfactorily installed and accepted by the Engineer.

Reset Temporary Crash Cushions will be measured and paid for as the actual number of crash cushion relocations as directed.

Payment will be made under:

Pay Item	Pay Unit
Temporary Crash Cushion	Each
Reset Temporary Crash Cushion	Each

SECTION 1165
TRUCK MOUNTED IMPACT ATTENUATORS

1165-1 DESCRIPTION

Furnish, install, operate, maintain, and relocate truck mounted impact attenuators (TMIA) in accordance with the contract.

1165-2 MATERIALS

(A) General:

Refer to Division 10:

Item	Section
Truck Mounted Impact Attenuators	1089-9

(B) Material Qualifications

Use TMIAs that meet the requirements of NCHRP 350 Test Level II or III for work zone traffic control devices and are on the Department's Approved Products List and are traffic-qualified by the Work Zone Traffic Control Unit.

(C) Historical Performance

Historical performance of the TMIA will help determine the future use of the material by the Department, even if the TMIA has been traffic-qualified. Poor past or poor current performance of TMIA at any site, whether or not related to a specific contract, may be grounds for non-acceptance of a product on any project under contract.

1165-3 CONSTRUCTION METHODS

Prior to use, furnish the Engineer detailed brochures, specifications, and other manufacturer's data that completely describes the performance criteria, installation, and instructions for the TMIA.

Use only TMIAs that meet the crash test requirements of Article 1089-9(A).

Do not park TMIAs against rigid objects (i.e. bridge piers or portable concrete barrier) except as a temporary safety measure and in no case for longer than 72 hours. Install the TMIA on a truck that is fully operational, in good running order, and in accordance with the manufacturer's specifications.

Use the appropriate lighting and delineation on the truck and TMIAs as shown in the contract.

1165-4 MAINTENANCE

Repair or replace within 24 hours any attenuator that becomes crushed or otherwise damaged so that it will perform its intended purpose. Suspend all construction activities until the attenuator is repaired or replaced. Provide safe control of traffic until the attenuator has been repaired by using approved methods.

1165-5 MEASUREMENT AND PAYMENT

TMIA will be measured and paid for as the maximum number of TMIAs acceptably placed and in use at any one time during the life of the project for all operations other than Moving and Mobile Operations. TMIAs are considered incidental to all moving and mobile operations. In the case of emergency situations, TMIAs will not be paid for when payment has already been made for a stationary unit.

Relocation of TMIAs are considered incidental to the measurement of the quantities of TMIAs and no separate payment will be made.

Payment will be made under:

Pay Item	Pay Unit
TMIA	Each

SECTION 1170
PORTABLE CONCRETE BARRIER

1170-1 DESCRIPTION

Furnish, install, secure, maintain, remove and reset portable concrete barrier in accordance with the contract.

1170-2 MATERIALS

(A) General:

Refer to Division 10:

Item	Section
Portable Concrete Barrier	1090
Guardrail and Barrier Delineators	1088-2

Provide Portable Concrete Barrier that meets the requirements of NCHRP 350 Test Level II for work zones that have a posted speed limit of 45 mph or less; and/or meet the requirements of NCHRP 350 Test Level III for work zones which have a posted speed limit greater than 45 mph.

(B) Material Qualifications

Use Portable Concrete Barrier that is on the Department's Approved Products List and is traffic-qualified by the Work Zone Traffic Control Unit.

(C) Historical Performance

Historical performance of the Portable Concrete Barrier will help determine future use of the material by the Department, even if the Portable Concrete Barrier has been traffic-qualified. Poor past or poor current performance of Portable Concrete Barrier at any site, whether or not related to a specific contract, may be grounds for non-acceptance of a product on any project under contract.

1170-3 CONSTRUCTION METHODS

(A) General

Place all types of portable concrete barrier as shown in the contract. When required by the plans, anchor barrier by an approved method as shown in the *Roadway Standard Drawings* and/or refer to Subarticle 1170-3(B).

Use any approved NCHRP 350 portable concrete barrier. Use one type of portable concrete barrier on any continuous run of barrier within the project.

Use portable concrete barrier (drainage), as shown in the *Roadway Standard Drawings*, to avoid trapping water in sags, vertical curves, areas of wedging and paving where super-elevations have been changed, and other low spots as directed. Provide adequate drainage behind the portable concrete barrier (drainage) installation.

Lift, place and reset portable concrete barrier units using a two-point pick up, or other acceptable method, which does not over-stress, damage, or mar the surface of the roadway. Do not use connection points for lifting purposes.

Do not use any barrier units that are cracked, damaged, chipped, or otherwise nonfunctional.

(B) Securing Barrier On Concrete and Asphalt Pavement Surfaces:

(1) Anchoring

Secure barrier to concrete and asphalt pavement surfaces using approved anchoring methods as follows:

(a) On concrete pavement surfaces where the back side of the portable concrete barrier is 4 feet or closer to the edge of a drop-off that is 3 feet deep or greater.

(b) On bridge decks after the removal of an existing bridge rail or in places where portable concrete barrier is used and the backside of the portable concrete barrier is 6 feet or closer to the edge of the bridge deck.

(c) On concrete and asphalt pavement surfaces where portable concrete barrier is used to separate opposite direction of traffic and either side of the portable concrete barrier is 2 feet or closer to the edge of either opposing travel lane.

(2) Anchoring Methods:

(a) General:

Use anchoring methods shown in *Roadway Standard Drawings*.

(b) Anchor holes:

Drill anchor holes normal to the surface of installation using a pneumatic drill with a depth indicator, unless another drilling method is allowed. Make sure that the diameter of the hole is in strict conformance with the plans or the manufacturer's recommendations. When directed, use a jig or fixture to ensure that correct positioning of the holes and proper alignment during the drilling process. Adjust hole locations, as necessary, to avoid encountering reinforcing steel. Immediately after drilling, brush the holes with a stiff-bristled brush of a sufficient size to effectively remove dust from the sides of the hole, and blow all holes free of all dust and debris

using oil free compressed air. Repeat this procedure until the hole is completely clean.

Inspect each hole immediately prior to placement of the adhesive and anchor. Rework any hole found to deviate from these requirements to ensure that an acceptable hole is achieved.

Check each hole with a depth gauge to ensure proper embedment depth.

Satisfactorily repair all spalled or damaged concrete.

Once the barrier and anchors are removed, fill the holes with an approved non-shrink, non-metallic grout (see Article 1054-6). These requirements may be waived if the bridge or roadway will no longer be used by traffic.

(3) Adhesive Anchoring Method

Mix adhesives in strict conformance with the manufacturer's instructions.

Pour the mixed adhesive into the hole. Agitate or rotate anchors to ensure complete wetting and encapsulation. Insert the anchors to the specified depth. Completely fill the anchor hole with adhesive and remove any excess adhesive flush with the pavement. Do not disturb any anchors while the adhesive is hardening.

Coat all anchors used with the adhesive bonding method with a debonding agent so they can be easily removed. Formulate the debonding agent such that it does not reduce the strength of the anchor system.

(4) Through the Deck Anchoring Method

Anchor barrier to bridge decks as shown in Roadway Standard Drawing 1170.01, sheet 4 of 4. Do not use this method on prestressed concrete bridge deck panels.

(C) Resetting Barrier

Reset portable concrete barrier as shown in the plans.

(D) Stockpiling

Stockpile the portable concrete barrier when the barrier is not utilized on the project or it becomes necessary to stockpile units between two (2) separate installations.

Stockpile the barrier at a location off the project of your choosing, unless otherwise noted in the plans or to a location within the project limits if provided. Provide the stockpile area at no cost to the Department.

(E) Barrier Delineators

Use any of the several alternate delineator types for barrier (see *Roadway Standard Drawings*) that are on the Department’s Approved Products List and are traffic-qualified by the Work Zone Traffic Control Unit.

Use only one delineator type for barrier throughout the project.

The delineators consist of a reflector and base or casing. Attach the delineator to the barrier as shown in the *Standard Drawings*. Use one attachment position throughout the project length.

Position delineators perpendicular to the centerline of the road. Use yellow delineators in the median and on the left side of one-way ramps, loops, or other one-way facilities. Use crystal delineators on the right side of divided highways, ramps, loops and all other one-way or two-way facilities. In all cases, the color of the delineator shall supplement the color of the adjacent edgelines.

1170-4 MEASUREMENT AND PAYMENT

*Portable Concrete Barrier ( )*will be measured and paid for as the actual number of linear feet that has been furnished, satisfactorily installed, accepted by the Engineer, maintained, and removed. Measurement will be made by counting the number of barrier units used and multiplying by the length of a unit.

Reset Portable Concrete Barrier ( ) will be measured and paid for as the number of linear feet of barrier that has been moved from one location on the project to another location on the project. Measurement will be made by counting the number of barrier units moved during any one move and multiplying by the length of a unit. Where barrier units are moved more than once, each move will be measured separately. Whenever the Engineer directs the Contractor to move barrier units from an installed location to a stockpile either on or off the project and then back to another installed location, the complete move from the first installed location to the next installed location will be measured as 2 moves.

There will be no measurement made of barrier delineators as they are considered incidental to the other pay items in this Specification.

Payment will be made under:

Pay Item	Pay Unit
Portable Concrete Barrier	Linear Foot
Portable concrete Barrier (Anchored)	Linear Foot
Portable concrete Barrier (Drainage)	Linear Foot
Reset portable concrete Barrier	Linear Foot
Reset portable concrete Barrier (Anchored)	Linear Foot
Reset portable concrete Barrier (Drainage)	Linear Foot

SECTION 1180
SKINNY DRUMS

1180-1 DESCRIPTION

Furnish, install, maintain, relocate, and remove Skinny Drums with ballast in accordance with the contract.

1180-2 MATERIALS.

Refer to Division 10:

Item	Section
Skinny Drums	1089-5

Provide Skinny Drums that are on the Department's Approved Products List and are traffic-qualified by the Work Zone Traffic Control Unit.

1180-3 CONSTRUCTION METHODS

Use the same type of reflective sheeting (minimum of Type III) on all Skinny Drums installed at any one time during the life of the project.

Use ballasting methods in accordance with manufacturer's specification.

Use Skinny Drums as follows:

Skinny Drums may be used in lieu of cones.

Space Skinny Drums equal in feet to the posted speed limit, not to exceed 50 foot spacing, in the tangent sections on multilane roadways.

Do not use Skinny Drums as follows:

Do not use Skinny Drums for tapers on multilane roadways.

Do not substitute Skinny Drums for normal drums or intermix with drums unless directed by the Engineer or the Traffic Control Plans.

Do not use Skinny Drums to separate two directions of travel that have been shifted on a multilane roadway unless directed by the Engineer or Traffic Control Plans.

Do not use Skinny Drums for lane closures on multilane roadways for longer than 3 consecutive days.

1180-4 MAINTENANCE

At no cost to the Department, immediately replace any Skinny Drum, ballast, or reflective sheeting that are torn, crushed, discolored, or otherwise damaged.

1180-5 MEASUREMENT AND PAYMENT

Skinny Drums will be measured and paid for as the actual number of Skinny Drums satisfactorily placed, accepted by the Engineer and in use at any one time during the life of the project.

Relocation of Skinny Drums is considered incidental to the measurement of the quantity of Skinny Drums and no separate payment will be made.

Payment will be made under:

Pay Item	Pay Unit
Skinny Drum	Each

DIVISION 12
PAVEMENT MARKINGS, MARKERS AND DELINEATION

SECTION 1205
PAVEMENT MARKING GENERAL REQUIREMENTS

1205-1 DESCRIPTION

Furnish, install and remove pavement markings in accordance with the contract.

1205-2 MATERIALS

(A) General

Refer to Division 10:

Item	Section
Pavement Markings	1087

(B) Material Qualifications

Use pavement markings, which are on the Department's Approved Products List or are traffic qualified by the Traffic Control Unit.

(C) Historical Performance

Historical performance of the pavement marking material will be used in determining future use of the material by the Department, even if the material has been traffic qualified. Poor past or poor current performance of pavement marking materials at any site, whether or not related to a specific contract may be grounds for nonacceptance of a product on any project under contract.

1205-3 CONSTRUCTION METHODS

Do not use handliners or any other non-truck mounted pavement marking machine to install pavement markings for long line applications of any one line longer than 1000 feet.

(A) Testing Procedures

All pavement marking materials and placement will be tested according to Materials and Test Unit Testing Procedure PM 1.0 as shown in the *NCDOT Construction Manual.* Install pavement markings in order to meet the retroreflectivity requirements as measured by an LTL 2000, LTL-X or Department approved mobile retroreflectometer.

(B) Application Equipment

(1) General for all Application Equipment

Use pavement marking application equipment such that all parts that come in contact with pavement marking material are constructed for easy accessibility during cleaning and maintenance.

Keep the marking guns of the application device in full view of the operators at all times. Use applicators that are mobile and maneuverable to the extent that straight lines can be followed and all standard curves can be made in true arcs.

(2) Glass Bead/Element Dispensing Equipment

Apply drop-on beads/elements to the surface of pavement long line markings using an automatic high pressurized bead dispenser or a pressurized mechanical feed, attached to the marking equipment. Hand liner type equipment is exempt from this requirement. Locate the bead/element applicator at the proper distance behind the application of pavement marking material to provide the proper amount of retroreflectivity. Equip the bead applicator with an automatic cut-off control synchronized with the cut-off control of the marking material.

Spread the beads/elements uniformly over the entire surface of the pavement marking material such that they are partially embedded in the pavement marking. A 60% bead/element embedment depth provides optimum retroreflectivity.

(C) Weather Limitations and Seasonal Limitations for all markings

Do not place pavement markings when moisture tests conducted on the pavement show signs of moisture presence on the pavement, or it is anticipated that damage causing moisture may occur during the installation and drying periods. See Section 12 of the *Construction Manual* for details.

(D) Time Limitations for Replacement

Multi-lane roadways (3 or more lanes) and ramps	Center Line, Lane Line, Railroad symbols, & school symbols	By the end of each workday's operation if the lane is opened to traffic (temporary paint may be used)
	Edge Lines, gore lines & all other symbols	By the end of the 3rd calendar after obliteration
Two-lane, two-way roadways	All centerline markings, railroad, & school symbols	By the end of the 5th calendar day after obilteration
	Edge Lines & all other symbols	By the end of the 15th calendar day after obliteration

A multilane facility is defined as any roadway having more than two lanes to include a two-lane / two-way roadway with a center two-way left turn lane.

(E) Premarking

Premark each installation of pavement marking materials prior to application on new pavement and when required to replace pavement marking, except when existing

markings are visible. Use premarking to guide in the placement of pavement markings. Get the premarking inspected and approved before placing the pavement marking materials.

Review and record the existing pavement markings prior to resurfacing and reestablish the new pavement markings using the record of existing markings in conjunction with the Standard Drawings, unless otherwise directed. In order to assure compliance with this specification, submit a pavement marking plan 7 calendar days before any pavement marking is placed.

(F) Surface Preparation and Curing Compound Removal

Prepare the pavement to accept pavement markings to insure maximum possible adhesion. Clean, seal and remove curing compound as necessary to insure that the markings adhere to the pavement. Obtain approval for all surface preparation methods prior to implementing.

Pavements shall be free of grease, oil, mud, dust, dirt, grass, loose gravel and other deleterious material, prior to applying pavement markings.

Prepare the pavement surface, including removal of curing compound, a minimum of 2" wider than the pavement markings to be placed, such that, an additional 1" of prepared area is on all sides of the pavement markings after they are applied.

Remove all curing compound and surface laitance on Portland cement concrete pavements where long-life pavement markings will be placed. Perform curing compound removal by high-pressure water or shot blasting methods. Ensure that the surface is free of all residue, laitance and debris prior to applying the pavement marking.

When surface preparation and curing compound removal operations are completed, blow the pavement surface clean by compressed air to remove residue or debris.

Curing compound removal will be paid for at the applicable contract unit price. All other surface preparation will be considered incidental to the work covered by this specification.

If required, apply a primer sealer to pavement surfaces before applying pavement marking material as recommended by the manufacturer. Apply primer sealer in a continuous film in such a way as to not cause any noticeable change in the appearance of the pavement markings. Submit a sample of the primer sealer to the Engineer, prior to application.

Conduct all pavement surface preparation including curing compound removal in such a manner that the pavement or joint material is not damaged or left in a condition that will mislead or misdirect the motorist. Repair any damage caused to the pavement, or joint materials caused by surface preparation or the removal of curing compound by acceptable methods and at no additional cost to the Department.

Where pavement surface preparation results in obscuring existing pavement markings of a lane occupied by traffic, immediately remove the residue, including dust, by approved methods.

(G) Application of Pavement Markings

(1) General for all types of Pavement Markings

Install pavement marking material that has a uniform thickness, a smooth surfaced crosssection throughout its entire length, width and length not less than the dimensions specified in the plans and that does not exceed the dimension by more than 1/2".

Do not apply pavement marking materials over a longitudinal joint. See Standard Drawing No. 1205.01 sheet 2 of 2 for details.

Install pavement marking lines that are straight or have uniform curvature and conform with the tangents, curves, and transitions as specified in the plans.

Produce finished lines that have well defined edges and are free of horizontal fluctuations. Do not exceed 1/2" in lateral deviation from the proposed location alignment at any point. Any greater deviations may be cause for requiring the material to be removed and replaced at no additional cost.

Apply all longitudinal pavement marking lines 8" or less in width with one pass of the pavement marking equipment. Pavement marking lines greater than 8" in width and pavement marking symbols may be applied with multiple passes of the pavement marking equipment

The stem portion of straight arrows shall be applied in a single pass and the stem portion of turn arrows is to be applied in a maximum of 2 passes of the application equipment. Arrowheads may be applied by multiple passes of the application equipment, not to exceed three passes.

Install all pavement marking lines, characters, and symbols that require multiple passes of the application equipment such that there are no gaps separating the application passes.

Install characters and symbols so that they conform to the sizes and shapes shown in the plans.

Use pavement marking material that is capable of accepting an overlay of compatible material.

Protect the pavement markings until they are track free. Remove any markings tracked by a vehicle by acceptable methods and at no additional expense to the Department.

Reapply any molten pavement marking that is crossed by a vehicle. Payment will only be made for 1 application of molten pavement marking.

Remove all pavement marking materials spilled on the road surface by acceptable methods at no additional expense to the Department.

Use yellow, white, and black pavement markings, without drop-on glass beads, that visually match the color chips that correspond to the Federal Test Standard Number 595a for the following colors. Use markings that when subjected to

accelerated weathering as described in U.S. Federal Specification No. (TT-P-115F) are within the tolerance limits of the color chips listed below:

WHITE:	Color 17886
YELLOW:	Color 13538
BLACK:	Color 37038

(2) Glass Bead/Element Application

Drop-On: Method where glass beads are dispensed by a pressurized mechanical feed or high pressure means onto the pavement marking as it is applied to the pavement. Drop-On bead dispensing for symbols and characters may be accomplished by gravitational methods such as hand scattering.

(3) Maintenance

See *Construction Manual*, Section 12, for details.

(H) Observation Period

Maintain responsibility for the pavement markings for a 180 day observation period beginning upon the satisfactory completion of all work required in the plans. Guarantee the markings under the payment and performance bond in accordance with Article 105-17.

Have traffic operating on the facility during the entire 180 day observation period unless otherwise directed.

During the 180 day observation period provide pavement marking material that shows no signs of failure due to blistering, excessive cracking, chipping, bleeding, staining, discoloration, oil content of the pavement materials, smearing or spreading under heat, deterioration due to contact with grease deposits, oil, diesel fuel, gasoline drippings, spilling, poor adhesion to the pavement materials, loss of reflectivity, vehicular damage, or normal wear.

Replace, at no additional expense to the Department, any pavement markings that do not perform satisfactorily under traffic during the 180 day observation.

(I) Removal of Pavement Markings

This work includes the removal of all types of pavement marking lines, symbols, and characters including removal for long life marking preparation. This work does not include removal of removable tape pavement markings.

Remove pavement marking lines, characters, and symbols by acceptable methods to the Engineer that will not materially or structurally damage the surface or the texture of the pavement. Leave the pavement surface in a condition that will not mislead or misdirect the motorist.

Where existing pavement markings are to be removed and replaced by other pavement markings, do not begin removal until adequate provisions have been made to complete the installation of the replacement markings. Remove pavement markings such that the surface is in proper condition for adequate bonding of the new

markings. Promptly remove any material deposited on the pavement as a result of removing pavement markings as the work progresses by acceptable methods. Provide the equipment necessary to control dust and the accumulation of debris resulting from the removal process. The removal equipment shall provide dust control and the capture of the removed material shall be done utilizing a separate vacuum equipped vehicle or other approved system. Perform the recovery process within the same operation as the removal. Do not let traffic use the lane where the removal is taking place until the recovery system is finished. Should the recovery system fail, cease removal operations until the recovery system is properly operating. The Contractor is responsible for all cleanup and proper disposal of all removed debris from the project site.

When using a grinding method for pavement removal, the equipment shall have multiple heads working in tandem to provide adequate preparation of the surface to accept the new marking material.

Do not apply polyurea pavement markings over existing pavement marking materials having less adherence than the polyurea. Application over existing pavement marking materials other than polyurea will require the existing pavement marking material to be removed, so that a minimum of 85 percent of the existing pavement marking is removed. However, if pavement is less than 6 months old and one 15 mils application of paint was placed on the pavement initially, do not remove the existing paint pavement markings.

Do not apply thermoplastic pavement markings over existing pavement marking materials having less adherence than the thermoplastic. Application over existing pavement marking materials other than thermoplastic will require the existing pavement marking material to be removed so that a minimum of 85 percent of the existing pavement marking surface is removed. Before applying thermoplastic pavement markings over the existing thermoplastic pavement markings, remove a minimum of 25 percent of the oxidized existing thermoplastic. However, if pavement is less than 6 month old and one 15 mil application of paint was placed on the pavement initially, do not remove the existing paint pavement markings.

Use black color #37038 in paint or tape, as determined by Contractor, to cover any remaining conflicting pavement marking after removal from asphalt pavement surfaces. Do not use black paint or tape on concrete pavement surfaces. The black paint will not have a defined shape or edges with a width not exceeding double of the existing lines. No direct payment will be made for black paint or tape.

(J) Pavement Marking Installer Qualifications

Have at least one member of every pavement marking crew certified through the NCDOT Pavement Marking Technician Certification Process. Keep the certification current throughout the life of the project. The certified crewmember is not required to be the same person throughout the life of the contract.

1205-4 THERMOPLASTIC (Alkyd/Maleic)

(A) Application Equipment

Use equipment to install hot thermoplastic pavement marking material that includes the following features:

Premelting Kettle: oil-jacketed or air-jacketed utilized for uniform heating and melting of the thermoplastic material. Use a kettle that is equipped with an automatic thermostat control device to provide positive temperature control and continuous mixing and agitation of the thermoplastic material. Do not premelt thermoplastic material in handliner type equipment.

Applicator Storage Kettle: Equip long line pavement marking vehicles with an automatic thermostat control device to maintain the thermoplastic material at the application temperature and provide continuous mixing and agitation of the thermoplastic material during installation. Construct the equipment so that all mixing and conveying parts, up to and including the application apparatus, maintains the thermoplastic pavement marking material at the specified installation temperature and which has a capacity of a minimum of 1500 lbs. of molten thermoplastic pavement marking material. Hand transfer is not allowed.

Hand Liner type application vehicles may contain the premelting and applicator storage functions in the same kettle. Agitation and mixing can be done manually. Drag box type and bucket type application is not allowed.

Use premelting and applicator storage kettles that meet the requirements of the National Board of Fire Underwriters, the National Fire Protection Association, and State and local authorities.

Use application equipment that is constructed to assure continuous uniformity in the thickness and width of the thermoplastic pavement marking.

Use application equipment that provides multiple width settings ranging from 4" to 12" and multiple thickness settings to achieve the pavement marking thickness ranging from 0.090" to 0.120". Special thickness equipment may be required for in lane or shoulder transverse rumble strip pavement markings.

Do not use spray thermoplastic unless approved by the Work Zone Traffic Control Unit.

(B) Weather Limitations and Seasonal Limitations

Do not apply thermoplastic pavement markings on existing or new pavements unless the ambient air temperature and the temperature of the pavement is 50°F or higher.

Do not apply thermoplastic pavement markings between the dates specified below:

East of I-95	December 15 and the following March 16
East of I-77 to and including I-95	November 30 and the following April 1
West of and including I-77	November 15 and the following April 16

Exception to the above: When traffic is maintained on a portion of roadway and thermoplastic pavement marking will not be placed within 30 calendar days due to seasonal limitations, place pavement marking paint and beads in accordance with Subarticle 1205-8(C).

(C) Application

Use only thermoplastic markings that are of the hot, machine applied type. Apply Alkyd/Maleic thermoplastic pavement markings by extrusion methods only. Extrusion may be accomplished using either conventional extrusion equipment or ribbon gun extrusion devices.

Apply Drop-on Beads uniformly to the surface of the molten thermoplastic material so that the beads are partially embedded and at a rate to immediately obtain the minimum reflectance values. At the time of installation, produce in place markings with the minimum retroreflective values shown below, as obtained with a LTL 2000 Retroreflectometer or Department approved mobile retroreflectometer. Maintain the retroreflective values shown below for a minimum of 30 days from the time of placement of the marking material.

White: 375 mcd/lux/m2

Yellow: 250 mcd/lux/m2

Ensure that the marking is uniformly retroreflective upon cooling and has the ability to resist deformation caused by traffic throughout its entire length.

A thin layer of pavement marking paint at the proper width may be placed prior to applying the thermoplastic markings. If this option is chosen, when not specified in the plans or by the Engineer, direct payment for the paint will not be made. Cover any such thin layer of pavement marking paint with thermoplastic pavement marking within 30 calendar days of placement. Apply the thin layer of pavement marking paint and beads at the rate necessary to produce a dry film thickness of 5 - 8 mils. Apply drop-on glass beads at a rate of 1-3 pounds per gallon of paint.

Provide drainage openings at intervals of 250 feet in edge lines placed on the inside of curves and in edge lines on the low side of tangents. Provide openings that are a maximum of 12" and a minimum of 6" in length.

Produce a cross sectional thickness of the thermoplastic markings above the surface of the pavement as follows:

240 mils	In-lane and shoulder-transverse pavement markings (rumble strips) may be placed in 2 passes.
120 mils	Center lines, skip lines, transverse bands, mini-skip lines, characters, and crosswalk lines.
90 mils	Edge lines, gore lines, diagonals, and arrow symbols.

(D) Observation Period:

Retroreflective measurements will be taken within 30 days prior to the end of the 180 day observation period. Maintain minimum retroreflective values as shown below throughout the 180 day observation period.

White: 325 mcd/lux/m2
Yellow: 200 mcd/lux/m2

At the end of the Observation Period, the thermoplastic pavement marking material shall be within 10 mils of the initial pavement marking thickness as required in the plan. Take the thickness measurements as specified by Materials and Tests Unit Procedure PM-1.0. See the *Construction Manual* for details.

1205-5 POLYUREA

(A) Weather Limitations

Do not apply polyurea pavement markings on existing or new pavements unless the ambient air temperature of the pavement is 40°F or higher.

(B) Application

Produce polyurea pavement marking lines that have a minimum dry thickness of 20 mils when placed on concrete and asphalt pavements.

Using the polyurea application equipment, apply the pavement marking materials simultaneously. Apply the polyurea resin, mixed at the proper ratio according to the manufacturer's recommendations, to the pavement surfaces within the proper application temperatures as determined by the material manufacturer. Inject reflective glass beads/elements into the molten (liquid) polyurea pavement markings.

Wait a minimum of 15 days before applying polyurea on new asphalt. Place a thin layer of pavement marking paint at the proper width prior to applying the polyurea markings during the 15 day waiting period. Apply the thin layer of pavement marking paint and beads at the rate necessary to produce a dry film thickness of 5-8 mils. Apply drop on beads at a rate of 1 – 3 pounds per gallon of paint. Direct payment for the pavement marking paint will not be made. Cover any such thin layer of paint with polyurea pavement marking within 30 calendar days of placement.

Apply glass beads/highly reflective elements according to manufacturer's recommendations. At the time of installation, maintain the retroreflective values shown below for a minimum of 30 days from the time of placement of marking material.

Standard Glass Beads
White 375 mcd/lux/m2
Yellow 250 mcd/lux/m2

Highly Reflective Elements
White: 800 mcd/lux/m2
Yellow: 500 mcd/lux/m2

Produce marking that, upon curing, is uniformly reflectorized and has the ability to resist deformation caused by traffic throughout its entire length.

The Contractor shall be certified by the manufacturer of the polyurea pavement marking material to install the manufacturer's material. Provide at least one member of each crew that completed this training. Furnish the Engineer written confirmation of the training from the material manufacturer prior to beginning work. Have the manufacturer's technical representative, or a manufacturer's certified representative, onsite during the entire installation of the product.

Provide a manufacturer's technical representative that is knowledgeable and familiar with the Contractor's application equipment prior to the installation of the polyurea pavement markings.

(C) Observation Period

Retroreflective measurements will be taken within 30 days prior to the end of the 180 day observation period. Maintain minimum retroreflective values shown below throughout the 180 day observation period from the time of placement of the marking material.

Standard Glass Beads
White: 325 mcd/lux/m2
Yellow: 200 mcd/lux/m2

Highly Reflective Elements
White: 700 mcd/lux/m2
Yellow: 400 mcd/lux/m2

If polyurea with highly reflective elements is snowplowed during the 180 day observation period, the polyurea pavement marking materials shall meet the following minimum retroreflective values:

White: 375 mcd/lux/m2
Yellow: 250 mcd/lux/m2

1205-6 COLD APPLIED PLASTIC

(A) Application Equipment

Use mechanical application equipment, defined as a mobile pavement marking machine specifically designed for use in applying pressure sensitive pavement marking tape of varying widths up to 12". Use an applicator equipped with rollers to

provide initial adhesion of the preformed, pressure sensitive marking tape with the pavement surface. Symbols and legends may be tamped by hand but shall be rolled with a weighted roller as per the manufacturer's recommendations. Tamp the Cold Applied Plastic pavement marking material with a 200 lb. weighted roller as per the manufacturer recommendations.

Surface preparation adhesive may be required depending on the type of Cold Applied Plastic. Refer to the manufacturers' specifications before applying Cold Applied Plastic.

Most overlay tape installations should be conducted at an ambient air temperature of 60° F and rising and a surface temperature of 70° F with an overnight temperature a minimum of 40° F the night before application. Check the manufacturer's specifications for actual requirements. Install Cold Applied Plastic pavement markings at ambient air temperature and pavement surface temperature per manufacturer's specifications. Wait at least 24 hours after a rain before applying cold applied plastic pavement marking.

Cold Applied Plastic pavement markings shall be between 15 - 90 mils thick.

(B) Types of Cold Applied Plastic

At the time of installation, Cold Applied Plastic pavement markings shall meet the following:

Type 1 – Permanent Standard Tape

White	400 mcd/lux/m2
Yellow	300 mcd/lux/m2

Typically a 2 year life cycle permanent tape used on roadways with an ADT of 5000 or less.

Type 2 – Permanent High Performance Tape

White	500 mcd/lux/m2
Yellow	300 mcd/lux/m2

Material may come as one piece with a black border with yellow or white in the center. Typically a 5 year permanent tape used on roadways with an ADT greater than 5000.

Type 3 – Permanent Wet Reflective High Performance Tape

White:	500 mcd/lux/m2 – Dry
	250 mdc/lux/m2 – Wet
Yellow:	300 mcd/lux/m2 – Dry
	250 mcd/lux/m2 – Wet

Wet reflective tape shall meet the above retroreflective values both wet and dry. The value measured under wet conditions shall be measured in accordance with ASTM E1710 when using a portable retroreflectometer and in accordance with ASTM E2176 Condition of Continuous Wetting.

Type 4 – Removable Tape

White	700 mcd/lux/m2
Yellow	400 mcd/lux/m2

1205-7 HEATED-IN-PLACE THERMOPLASTIC

(A) Application Equipment

Apply Heated-In-Place Thermoplastic using a propane blow torch and other material as recommended by the manufacturer.

(B) Weather Limitations

Apply Heated-In-Place Thermoplastic only when ambient air temperature and pavement surface temperature is 32°F and rising.

(C) Applications

Apply Heated-In-Place Thermoplastic per manufacturer's specifications. The manufacturer shall certify the Installer of Heated-In-Place Thermoplastic. See the *Construction Manual* for details.

The Contractor may choose to use Heated-In-Place Thermoplastic symbols, characters, and transverse lines in lieu of molten thermoplastics pavement markings at no additional cost to the Department.

Produce a cross sectional thickness of installed Heated-In-Place thermoplastic markings above the surface of the pavement after installation and upon cooling as follows:

240 mils	In lane and shoulder transverse pavement markings rumble strips may be placed in 2 passes.
120 mils	Center-lines, skip lines, transverse bands, mini-skip lines, characters, and crosswalk lines.
90 mils	edge lines, gore lines, diagonals, and arrow symbols.

For initial minimum retroreflective value requirements, see Subarticle 1205-4(C).

(D) Observation Period

See Subarticle 1205-4(D).

1205-8 PAINT

(A) Application Equipment

The equipment to apply paint to pavements shall be a truck mounted pneumatic spray machine with suitable arrangements of atomizing nozzles and controls to obtain the specified markings. Paint pavement markings application equipment shall be capable of placing double solid lines, single solid lines, intermittent skip lines, or a combination of solid and intermittent skip lines in a single pass. This equipment shall also have an internal timing mechanism for measurement and controlled output of required line lengths.

The paint applicator equipment shall have at least two paint tanks with a minimum 60 gallon capacity and one tank for glass beads with a minimum of 500 lb. capacity. The pneumatic spray guns used for hand held paint pavement marking application shall be operable from the application truck. All metal parts that hold or transfer paint pavement marking material shall be stainless steel. The paint trucks shall be equipped with quick action valves. The required gauges and pressure regulators shall be conveniently located and in full view and reach of the operator. Paint strainers are required in paint supply lines.

The paint applicator shall be equipped with a dispenser for the glass beads as described in Subarticle 1205-3(B)(2). Provide a glass bead dispenser that operates automatically and simultaneously with the paint applicator through the same mechanism and that is capable of adjustment and designed to provide uniform flow over the full length and width of the stripe as specified in Subarticle 1205-3(G)(2).

Provide pneumatic spray guns for hand application of detail markings, symbols, and legends. A hand operated push type applicator with a glass bead dispenser may be used of radii and/or parking spaces.

(B) Weather Limitations

Apply paint only when the ambient air temperature and pavement surface temperatures are a minimum of 40°F and rising and a maximum of 160°F.

(C) Application

Final pavement marking applications of paint shall be placed in two applications of 15 mils wet each. Apply the second application of paint upon sufficient drying time of the first. Each application of paint shall consist of drop-on beads applied at a rate to immediately obtain the minimum retroreflective values. Take the thickness measurements as specified by Materials and Tests unit Procedure 1.0. See the *Construction Manual* for details.

When paint is required by the Engineer or Traffic Control Plan for temporary pavement markings during temporary traffic patterns, apply one application of paint at 15 mils wet. If the temporary traffic pattern will last longer than six months, apply a second application of paint six months after the initial application. Additional applications of paint at 15 mils wet may be applied every six months as directed by the Engineer or Traffic Control Plan.

For each 15 mil application of paint, apply drop-on beads uniformly to the surface of the paint material at a rate to immediately obtain the minimum retroreflective values. At the time of installation, produce in-place markings with the minimum retroreflective values shown below, as obtained with a LTL 2000 Retroreflectometer or Department approved 30m mobile retroreflectometer. Maintain the retroreflective values shown below for a minimum of 30 days from the time of placement of the marking material.

White	225 mcd/lux/m^2
Yellow	200 mcd/lux/m^2

Make sure that the marking is uniformly retroreflectorized upon drying.

(D) Observation Period

Measurements will be taken within 30 days prior to the end of the 180 day Observation Period. Maintain minimum retroreflective values shown below for a minimum of 180 days from the time of placement of the marking material.

White: 200 mcd/lux/m2
Yellow: 180 mcd/lux/m2

1205-9 MAINTENANCE

Replace pavement markings that prematurely deteriorate, fail to adhere to the pavement, lack reflectorization, or are otherwise unsatisfactory, during the life of the project or during the 180 day observation period as determined by the Engineer at no cost to the Department.

Upon notification from the Engineer, winterize the existing pavement markings on the project by placing an additional application of markings. The markings shall be suitable for use in winter periods whether in a temporary or final pattern. Payment will be made under the pay item for the type of marking placed.

1205-10 MEASUREMENT AND PAYMENT

Pavement Marking Lines will be measured and paid for as the actual number of linear feet of pavement marking lines that have been satisfactorily placed and accepted by the Engineer. The quantity of solid lines will be the summation of the linear feet of solid line measured end-to-end of the line. The quantity of skip or broken lines will be the summation of the linear feet derived by multiplying the nominal length of a line by the number of marking lines satisfactorily placed.

Pavement Marking Symbols will be measured and paid for as the actual number of pavement marking symbols that have been satisfactorily placed and accepted by the Engineer.

Pavement Marking Characters will be measured and paid for as the actual number of characters satisfactorily placed and accepted by the Engineer. A character is considered to be one letter or one number of a word message.

Removal of Pavement Marking Lines will be measured and paid for as the actual number of linear feet of pavement marking lines that have been satisfactorily removed and accepted by the Engineer. The quantity of solid lines will be the summation of the linear feet of solid line measured end-to-end of the line. The quantity of skip or broken lines will be the summation of the linear feet derived by multiplying the nominal length of a line by the number of marking lines satisfactorily removed. No payment will be made for the removal of removable pavement marking tape.

Removal of Pavement Marking Symbols & Characters will be measured and paid for as the actual number of pavement marking symbols and characters that have been satisfactorily removed and accepted by the Engineer.

Curing Compound Removal, Lines will be measured and paid for as the actual number of linear feet of pavement surface from which the curing compounds are satisfactorily removed. Measurement will be made along the surface of the pavement.

Curing Compound Removal, Symbols & Characters will be measured and paid for as the actual number of symbols and characters for which the curing compound has been satisfactorily removed.

Payment at the contract unit price for the various items in the contract will be full compensation for all the items covered by this section. No direct payment will be made for: the work involved in applying the lines, including surface preparation; reapplication of molten pavement marking crossed by a vehicle; and removal of all pavement marking materials spilled on the roadway surface.

Payment will be made under:

Pay Item	**Pay Unit**
Paint Pavement Marking Lines, __"	Linear Foot
Thermoplastic Pavement Marking Lines, __", __mils	Linear Foot
Polyurea Pavement Marking Lines; ___"	Linear Foot
Cold Applied Plastic Pavement Marking Lines, Type __ (__"):	Linear Foot
Heated-In-Place Thermoplastic Pavement Marking Lines, __", __mils	Linear Foot
Paint Pavement Marking Symbols	Each
Thermoplastic Pavement Marking Symbols, __mils:	Each
Polyurea Pavement Marking Symbols	Each
Cold Applied Plastic Pavement Marking Symbols, Type ___	Each
Heated-In-Place Thermoplastic Pavement Marking Symbols, __mils	Each
Paint Pavement Marking Characters	Each
Thermoplastic Pavement Marking Characters, __mils	Each
Polyurea Pavement Marking Characters	Each
Cold Applied Plastic Pavement Marking Characters, Type ___	Each
Heated-In-Place Pavement Marking Characters __mils	Each
Removal of Pavement Marking Lines, __"	Linear Foot
Removal of Pavement Marking Symbols & Characters	Each
Curing Compound Removal, Lines	Linear Foot
Curing Compound Removal, Symbols & Characters	Each

SECTION 1250
GENERAL REQUIREMENTS FOR PAVEMENT MARKERS

1250-1 DESCRIPTION

Furnish and place pavement markers in accordance with the contract.

1250-2 MATERIALS

(A) General

Refer to Division 10:

Item	Section
Pavement Markers	1086

(B) Material Qualifications

Use pavement markers that are on the Department's Approved Products List, are traffic qualified by the Traffic Control Unit and have been evaluated by NTPEP.

(C) Historical Performance

Historical performance of the pavement markers will be used in determining future use of the pavement markers by the Department, even if the pavement markers have been traffic qualified. Poor past or poor current performance of pavement markers at any site, whether or not related to a specific contract may be grounds for nonacceptance of a product on any project under contract.

1250-3 CONSTRUCTION METHODS

(A) Weather Limitations

Do not install pavement markers or replacement reflectors if moisture tests performed on the pavement indicate the presence of moisture on the pavement surface or on the pavement marker. Install all pavement marker adhesives as required by the manufacturer's specifications for weather and temperature limitations.

(B) Preparing for installation

Ensure that the pavement, pavement markers, and replacement lens are free of dirt, dust, oil, grease, moisture, curing compound, loose or unsound layers, or any other material that would interfere with proper bonding of the marker to the pavement or the lens to the marker. Use methods approved by the Engineer for this preparation.

(C) Removal of Existing Pavement Markers

Remove existing pavement markers prior to overlaying an existing roadway with pavement. Repair the pavement by filling holes as directed. When traffic patterns are changed, remove pavement markers that conflict with the new traffic pattern prior to switching traffic to the new traffic pattern.

Properly dispose of the removed pavement markers. No direct payment will be made for removal of existing pavement markers or repair of pavement, as such work will be considered incidental to other items in the contract.

(D) Installation

(1) General

Install all pavement markers and adhesives per manufacturer's specifications.

(2) Color

Ensure that the color of the reflector corresponds to the pavement marking that the marker supplements. Red reflectors may be required in combination with crystal or yellow reflectors to indicate wrong way movement when viewed in the direction opposing the flow of traffic.

(3) Appearance

Remove any adhesive from the reflective lens of the marker; otherwise, replace the reflector lenses of a snowplowable pavement marker or the entire raised pavement marker.

(4) Spacing

Space pavement markers as shown in the plans. Position pavement marker lenses perpendicular to the flow of traffic as shown in the Standard Drawings. Adjust marker longitudinal spacing up to 1 foot in either direction and/or adjust marker lateral spacing up to 3" to avoid installation of the marker at a pavement construction joint or surface defect. If a marker can not be relocated as described above, do not install the affected marker.

(E) Pavement Marker Installer Qualifications

Have at least one member of every pavement marker crew certified through the NCDOT Pavement Marking Technician Certification Process. Keep the certification current throughout the life of the project. The certified crewmember is not required to be the same person throughout the life of the contract.

SECTION 1251
RAISED PAVEMENT MARKERS

1251-1 DESCRIPTION

Furnish, install, maintain and remove temporary and permanent raised pavement markers in accordance with the contract.

1251-2 MATERIALS

Refer to Division 10:

Item	Section
Temporary Raised Pavement Markers	1086-1
Permanent Raised Pavement Markers	1086-2

1251-3 CONSTRUCTION METHODS

Install temporary raised pavement markers on the nonfinal pavement surfaces with epoxy, pressure sensitive adhesives or hot bitumen adhesives.

Install permanent raised pavement markers using a hot bitumen adhesive in accordance with Article 1081-7.

On final pavement surfaces, install temporary raised pavement markers using a pressure sensitive adhesive or hot bitumen adhesive. When using a pressure sensitive adhesive, install a primer/sealer when required by the manufacturer's specifications.

1251-4 MAINTENANCE

Maintain all installed temporary raised pavement markers. Replace all damaged or missing temporary raised pavement markers if any of the following occurs:

Three segment failures occur in any roadway section. Three consecutive damaged or missing markers in any group of seven represents a segment failure.

Twenty percent of the markers in any roadway section are damaged or missing.

Engineer determines replacement is necessary.

Replace markers from the time of the initial installation up to 180 days at no cost to the Department. After 180 days, any marker replacement not caused by the Contractor’s negligence or material failure will be paid for in accordance with Article 1251-5.

Maintain all installed permanent raised pavement markers prior to acceptance.

1251-5 MEASUREMENT AND PAYMENT

Temporary Raised Pavement Markers will be measured and paid for as the actual number of temporary raised pavement markers that have been satisfactorily placed and accepted by the Engineer.

Permanent Raised Pavement Markers will be measured and paid for as the actual number of permanent raised pavement markers that have been satisfactorily placed and accepted by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Temporary Raised Pavement Markers	Each
Permanent Raised Pavement Markers	Each

SECTION 1253
SNOWPLOWABLE PAVEMENT MARKERS

1253-1 DESCRIPTION

Furnish, install and maintain snowplowable pavement markers in accordance with the contract.

1253-2 MATERIALS.

Refer to Division 10:

Item	Section
Snowplowable Pavement Markers	1086-3

1253-3 CONSTRUCTION METHODS

(A) General

Bond marker castings to the pavement with epoxy adhesive. Mechanically mix and dispense epoxy adhesives as required by the manufacturer's specifications. Place the markers immediately after the adhesive has been mixed and dispensed.

Install snowplowable pavement marker castings into slots sawcut into the pavement. Make slots in the pavement to exactly duplicate the shape of the casting of the snowplowable pavement markers.

Promptly remove all debris resulting from the saw cutting operation from the pavement surface. Install the marker castings within 7 calendar days after sawcutting slots in the pavement. Remove and dispose of loose material from the slots by brushing, blow cleaning, or vacuuming. Dry the slots prior to applying the epoxy adhesive. Fill the cleaned slots totally with epoxy adhesive flush with the surface of the existing pavement. Install snowplowable pavement markers according to the manufacturer’s recommendations.

Protect the snowplowable pavement markers until the epoxy has initially cured and is track free.

(B) Reflector Replacement

In the event that a reflector is damaged, replace the damaged reflector by using adhesives and methods recommended by the manufacturer of the markers and approved by the Engineer. This work is considered incidental to the installation and maintenance of snowplowable markers specified in this section.

(C) Recycled Snowplowable Pavement Marker Castings

Use properly refurbished snowplowable pavement marker castings as approved by the Engineer such that approved new reflectors can be installed inside the castings.

1253-4 MAINTENANCE

Maintain all installed snowplowable raised pavement markers prior to acceptance.

1253-5 MEASUREMENT AND PAYMENT

Snowplowable Pavement Markers will be measured and paid for as the actual number of snowplowable pavement markers satisfactorily placed and accepted by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Snowplowable Pavement Marker	Each

SECTION 1264
OBJECT MARKERS

1264-1 DESCRIPTION

Furnish and install object markers in accordance with the contract.

1264-2 MATERIALS

Refer to Division 10

Item	Section
Object markers	1088-5
U-channel posts	1094-1(B) & (C)
Joint Sealer	1028-2

1264-3 CONSTRUCTION METHODS

Use Type 1 object markers to mark obstructions within the roadway. Mount on sign supports to supplement a sign, or mount individually on 7' U-channel posts, or mount on the actual obstruction.

Use Type 2 object markers to mark obstructions that are not in the roadway. Mount Type 2 Object Markers on the back of sign supports located in the median of divided roadways, and the outside of two-lane, two-way roadways where the sign is facing the opposing traffic direction. Place Type 2 object markers on the side nearest the traffic approaching the back of the sign supports. If guardrail is used to protect the sign supports, or where two signs are mounted back to back, Type 2 object markers are not required.

Use Type 3 object markers to mark larger obstructions within or outside the roadway, such as bridge piers, abutments and rails, culvert headwalls, or narrow shoulder drop-offs. Have the stripes slope downward toward the side of the obstruction on which traffic is to pass. They may be required to be mounted on the actual obstruction or individually on 7' U-channel posts.

Mount End of Road object markers on 7' U-channel posts at the end of a roadway where there is no alternate vehicular path.

1264-4 MEASUREMENT AND PAYMENT

Object Markers (Type__) will be measured and paid for as the actual number of object markers satisfactorily placed and accepted by the Engineer

7' U-Channel Posts will be measured and paid for as the actual number of 7' U-Channel posts satisfactorily placed and accepted by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Object Markers (Type 1)	Each
Object Markers (Type 2)	Each
Object Markers (Type 3)	Each
Object Markers (End of Road)	Each
7' U-Channel Posts	Each

SECTION 1266
TUBULAR MARKERS (FIXED)

1266-1 DESCRIPTION

Furnish, install, relocate, maintain and remove tubular markers in accordance with the contract.

MATERIALS

Refer to Division 10

Item	Section
Tubular Markers	1088-7

1266-3 CONSTRUCTION METHODS

Secure tubular markers to the pavement surfaces using epoxy or other approved types of adhesives.

Use tubular markers affixed to pavement surfaces as a supplement to pavement markings to channelize traffic. Use tubular marker such that the color of the tubular marker and retroreflective sheeting would match the color of the pavement markings they supplement, except as noted below:

- Use orange tubular markers with white and crystal retroreflective sheeting on top of asphalt islands as shown in the plans.

- Use orange tubular markers affixed to pavement surfaces with white and crystal retroreflective sheeting to separate opposing traffic placed on one side of a 4 lane divided highway.
- Gray tubular markers with white/crystal retroreflective sheeting may be used to supplement white pavement markings.

1266-4 MAINTENANCE

Inspect and replace any worn out tubular markers at no cost to the Department.

Inspect and replace all damaged or missing tubular markers if any of the following occurs in accordance with Article 1266-5:

Three segment failures occur in any roadway section. Two consecutive damaged or missing tubular markers in any group of seven represents a segment failure

Twenty percent of the total numbers of tubular markers in any roadway section are damaged or missing.

Engineer determines replacement is necessary.

1266-5 MEASUREMENT AND PAYMENT

Tubular Markers (Fixed) will be measured and paid for as the maximum number of tubular markers satisfactorily placed and accepted by the Engineer at any one time during the life of the project.

Payment will be made under:

Pay Item	Pay Unit
Tubular Markers (Fixed)	Each

SECTION 1267
FLEXIBLE DELINEATORS

1267-1 DESCRIPTION

Furnish and install flexible delineators in accordance with the contract.

1267-2 MATERIALS

Refer to Division 10.

Item	Section
Flexible Delineators	1088-8

1267-3 CONSTRUCTION METHODS

Use yellow, red, or crystal retroreflective sheeting as shown in the plans. Place the retroreflective sheeting on the front and back of the delineator post as required by the plans.

Install the delineator post so that the entire width of the retroreflective sheeting is visible to approaching traffic.

Install the delineator post so the top of the reflective sheeting is 48" above the near edge of roadway surface.

Install the delineator post and base support according to the manufacturer's specifications.

Install the flexible delineators plumb on all sides.

Provide a post such that both sides of the top of the post accepts, and holds securely, retroreflectorized sheeting. The color of the post shall be gray.

Install the post such that the post length provides for adequate ground penetration for proper performance.

Attach the flexible delineator post to the base support using 2 hex head bolts, flat washers, lock washers and deformed thread hex nuts. Tighten the bolts to a minimum 20 ft-lbs torque.

Position delineators perpendicular to the centerline of the road. Use yellow delineators in median and on the left side of one-way ramps, loops, or other one-way facilities. Use crystal delineators on the right side of divided highways, ramps, loops and all other one-way or two-way facilities. In all cases, use delineators whose colored retroreflective sheeting supplements the color of the adjacent edgeline

Design the delineator post for a permanent installation to resist overturning, twisting, and displacement from wind and impact forces.

1267-4 MAINTENANCE

Maintain all installed flexible delineators prior to acceptance.

1267-5 MEASUREMENT AND PAYMENT

Flexible Delineators (color) will be measured and paid for as the actual number of flexible delineators that have been satisfactorily installed and accepted by the Engineer.

Payment will be made under:

Pay Item	**Pay Unit**
Flexible Delineator (Crystal)	Each
Flexible Delineator (Yellow)	Each
Flexible Delineator (Crystal & Red)	Each
Flexible Delineator (Yellow & Red)	Each

DIVISION 14
LIGHTING

SECTION 1400
ROADWAY LIGHTING

1400-1 DESCRIPTION

Furnish, install, connect, and place into satisfactory operating condition lighting at locations shown on the plans. Perform all work in accordance with the contract and the National Electrical Code.

This division is for methods, materials and equipment to construct and put in working order the proposed lighting; however, every fitting, minor detail, or feature may not be shown or described. The Contractor shall be an expert in the trade, capable of understanding the intent of the contract and constructing the lighting and electrical system(s) in accordance with the best practice of the trade.

The Contractor actually performing the work described in the contract shall have a license of the proper classification from the North Carolina State Board of Examiners of Electrical Contractors.

Have the licensed contractor available on the job site as necessary when work is being performed or when requested by the Engineer. Have this contractor maintain a set of project plans and Specifications in his possession on the job site and a set of accurate as built plans. This contractor shall be qualified to responsibly instruct and direct all employees regarding the electrical work.

1400-2 MATERIALS

(A) General

All materials used in the work are to be new materials unless noted elsewhere in the contract. References in the contract to any proprietary device, product, material, fixture, form, type of construction, etc. by make or catalog number, with or without the words or approved equal, is to be taken as establishing a standard of quality, and is not to be construed as limiting competition. In such case, the Contractor may use any material, equipment or type of construction which has written approval as being an acceptable equal to that named for the particular use intended by the contract.

Provide materials that are labeled or listed by an acceptable organization, which is defined as an organization that maintains periodic inspection of the production of the materials and verifies, by the labeling or listing procedure, that the materials comply with appropriate standards of performance or are suitable for use in a specified manner. Provide Underwriters' Laboratories (UL) labeled and listed materials when such labeling and listing is available for such materials.

Make sure that materials are in compliance with requirements for use of domestic products, as specified in other sections of the Specifications.

(B) Conduit

Use conduit and duct that is either metallic (Rigid Metallic Conduit) or non-metallic (Polyvinyl Chloride or High Density Polyethylene), as noted on the plans and as described in Section 1098-4.

(C) Wire

Use stranded copper conductors unless specifically noted otherwise on the contract. Use wire and cable which conforms to IPCEA specifications and has marks for identification (manufacturer's name, type insulation, and gauge of conductor) and the UL label.

Use wire insulation rated at 600 VAC or greater.

Use the following types of wiring unless noted otherwise on the plans:

Service Lateral	UL Type USE
Control System	UL Type THW or RHW or THHN
Feeder Circuits in Conduit	UL Type USE
Branch Circuits in Light Standards	UL Type NM Cable
Equipment Grounding Conductor	Solid MHD, Bare or Insulated
Grounding Electrode Conductor	ASTM B-2

Feeder circuits in conduit with #8 conductors and smaller may consist of a cable assembly rated UL Type UF. Use #6 AWG for the grounding electrode conductor unless noted larger on the plans.

(D) Grounding and Bonding Equipment

Use Ground Rods which are 5/8" diameter x 8' copper clad steel and which have a one piece silicone bronze clamp with a socket or hex head screw. Make sure that all grounding and bonding equipment conforms to UL Standard 467*, Electrical Grounding and Bonding Equipment*.

(E) Fuseholders

Provide fused overcurrent protection in the base of each light standard, and other locations as noted. Use a fuseholder that is rated 600 VAC, 30 amp minimum, waterproof, and constructed so that the fuse will be disconnected from the line side power every time the fuseholder is opened. It may be made of molded plastic or rubber and have insulating boots. Use terminals which are specifically rated for the size and number of conductors required.

Use fuses which have 5000 amp minimum interrupting capacity at the supply voltage, are rated 10 amp or as noted on the plans, and are not glass type unless specified different in the contract. Use the same type fuse in all fuseholders on a project unless specified differently at specified locations.

Use fuseholders that have been specifically designed as breakaway devices in fiberglass standards and standards with breakaway bases. Use fuseholders that have been designed to disconnect line side power without damage to the terminals or conductors every time sufficient pulling force is placed on the line and load side conductors.

(F) Hardware

Use mounting or attachment hardware including bolts, nuts, washers, straps, clamps, and hangers which is made of stainless steel, hot dipped galvanized or of equal corrosion resistance. Use bolts, which are minimum length and are not less than 1 nominal size smaller than the opening being utilized.

(G) Lamps

Use lamps that conform to ANSI specifications, are of the type and wattage indicated on the contract, are rated for a minimum of 24,000 hours life, have a mogul base, and have special coatings for premium efficiency and color rendition. Clearly mark the installation date on the base. Provide and install lamps for all luminaires furnished on the project.

(H) Duct and Conduit Sealer

(1) Use duct and conduit sealer or mastic which is a putty-like compound and:

(2) is permanently non-hardening, non-oxidizing, and non-corrosive to metals, rubber, plastic, lacquer and paints,

(3) is readily workable for thumbing into openings and forming into seals around wires inside conduits and openings around conduits,

(4) has a service temperature range of minus 30°F to 200°F

(5) is clean, non-poisonous and non-injurious to human skin,

(6) seals against water, dust and air and shall adhere to wood, glass, plastics, metal, rubber, and painted surfaces.

(I) Pull Lines

Place pull lines specifically designed for pulling a rope in all empty conduits and electrical duct so that electrical circuits can be installed in the future. Use pull lines which are 2 ply with a tensile strength of 240 pounds minimum and resistant to tangling, rot, and mildew.

1400-3 SUBMITTALS

(A) Catalog Cuts

Submit for approval catalog cuts and/or shop drawings for materials proposed for use on the project. Allow 40 days for review of each submittal. Do not deliver materials which have not been approved to the project. Submit 8 copies of each catalog cut and/or drawing and show for each the material description, brand name, stock-number, size, rating, manufacturing specification and the use for which it is intended.

Three copies of approved submittals will be returned to the Contractor. Present a catalog cut or drawing for all components of each contract item. Present the submittals neatly arranged in the same order as the contract bid items.

(B) Certifications

In accordance with Article 106-3, furnish a Type 3 - Manufacturer's Certifications for light standards, high mounts and lowering devices and a Type 6 - Supplier's Certifications for conductors. Submit certifications when the above materials are delivered to the project.

Type 3 or Type 6 Certifications may be requested for any or all of the other material which does not have a name plate showing sufficient information to verify that the material was manufactured to the requirements of these Specifications.

(C) Samples

Random samples will be taken of the various items for the purpose of verifying conformance with Specifications. The selection of the items to be sampled and the taking of the samples will be done by the Engineer.

Failure to meet specification requirements by 2 samples of any material will be sufficient reason for rejection of all materials from the same lot.

Upon request, there will be reimbursement for the actual verified cost of such material taken as samples, including any handling charges less any discount allowed on the invoice, but with no percentage added, and such material will thereafter become the property of the Department.

(D) As-Built Plans

Submit two complete sets of as-built plans for review upon completion of the work, showing the location of all buried electrical circuits, with pavement crossings dimensioned from fixed objects or from survey stations.

Include in the as-built plans the title (No. 1), index (No. 1A), summary of quantities (No. 3), and all of the layout and detail (E) sheets of the project with all changes indicated. After review and approval, place one set of these as-built plans in a waterproof envelope and file in each Control Panel.

Submit one set of as-built plans to the Roadway Design Unit.

Show the light standard foundations that are relocated (by permission of the Engineer) on the as-built plans in their final locations.

Keep a daily record of the location of all items in order to ensure the accuracy of the as-built plans.

(E) Warranties

Turn over warranties from each manufacturer of electrical materials and equipment pertinent to the complete and satisfactory operation of the system prior to the acceptance of the project. Indicate on each warranty furnished its expiration date; it shall not be less than those provided as a customary trade practice.

(F) Computations and Welding Procedures

Submittals of structural design computations and drawings showing material and welding specifications as required in other sections of the Specifications, such as High Mount Standards, may require 10 weeks for review.

1400-4 CONSTRUCTION METHODS

(A) Location Surveys

All light standards, high mount foundations, and electrical duct will be located unless indicated differently elsewhere in the contract. Mark the proposed location of circuits, circuit markers, control systems, service poles, junction boxes, luminaires, and all other components for approval prior to installation. The top of foundation elevations will be provided unless indicated differently.

The plan locations of the light standards and high mounts may be adjusted in order to be behind guardrail, to avoid obstructions, or to avoid undesirable foundation conditions. Have location changes approved prior to construction. Have longitudinal relocations of luminaires of more than 10 feet or lateral relocations of more than 2 feet approved by the Roadway Design Unit.

Verify project dimensions on the site, actual measurement always taking precedence over scaled plan dimensions, with every part of the work fitted to actual conditions at the site.

(B) Damage to Facilities

Take all precautions necessary to avoid damage to existing underdrains and other buried facilities located in certain areas. Hand trenching may be required to avoid damage to the underdrains, storm sewer systems and other facilities. Construct light pole foundations which have a minimum horizontal clearance of 10 feet to storm sewers or other underground installations which might affect the foundation stability. Make lateral and longitudinal changes in pole locations in the field to provide the required clearance, as directed.

Trenching and construction operations may require the removal of or result in damage to existing shoulders and paved ditches. Restore all disturbed portions of the project to their original condition or as approved.

Installation of conductors may require trenching through existing guardrail locations. Trenching may be done beneath the guardrail in a manner that will not disturb the guardrail installation or the Contractor may remove short sections of guardrail to facilitate mechanical trenching. Reinstall all removed guardrail by the end of the day's work. Permission is required prior to removal of any guardrail. Repair any damage to the guardrail installation or to the galvanizing of the material as directed.

Repair all trenched, excavated, or otherwise damaged earth surface areas by shaping, smoothing, seeding, and mulching the damaged areas as required by the Specifications and as directed.

(C) Existing Utilities

Water, sewer, telephone, fire alarm, traffic signal, and power lines may be located in the same area that lighting standards and circuits are to be installed.

Locate these lines before operations are begun. Field changes approved by the Engineer may be made to provide clearance required by the National Electrical Safety Code.

Foundations or other construction which is installed in conflict with existing utilities will not be acceptable. Remove this construction and repair damage to utilities at no cost to the Department.

When the work involves replacing or renovating existing lighting, make all reasonable efforts to prevent dark spots in the lighting system. Phase lighting construction to allow existing lighting to remain in operation as long as possible.

(D) Operation of Equipment

Use a bucket truck to raise workers into position to install and/or adjust luminaires and lamps after the initial setting of the standards. Taking down the light standard to check or make adjustments at the top is not allowed.

Install all bore pits outside the clear zone.

(E) Conduit Installation

Install conduit continuous, watertight, free of kinks, and make all runs with as few couplings as standard lengths will permit. Do not exceed a total angle of 270° between outlets unless otherwise approved. Conduit bodies with covers and neoprene gaskets may be used to facilitate the installation of the wires at locations indicated on the plans.

Provide protection at all times against the entrance of water or other foreign matter into the conduit. Plug or cap conduit when work is temporarily suspended, including nightly stoppage of work.

Clean all conduits before installation, and upon completion of the system. Snake an approved cleaner with a diameter not less than 85% of the nominal diameter of the conduit through each conduit prior to installing the wire.

Install the conduit in such a manner that temperature changes will not cause elongation or contraction that might damage the system. Provide expansion fittings where conduit crosses structure expansion joints.

Avoid short radius bends in non-metallic conduit to prevent burn-through of the pulling cable or conductors during pulling operations.

Install caps or plugs on stub-outs for future use made of the same material as the conduit. Where non-metallic conduit is joined to metallic conduit, use a non-metallic female threaded adapter. Install bushings on all conduit ends projecting into panels, boxes, or other enclosures. Provide pull lines in all conduits for future installation of circuitry. Coat field cut threads and other uncoated metal or damaged galvanizing with organic zinc repair paint. Securely fasten conduit. For the spacing of fasteners,

do not exceed 4' for 1 1/2" conduit and larger or 6' for 1 1/4" conduit and smaller. Use fasteners that are hot dipped galvanized or stainless steel. Provide backs with all conduit straps installed on flat surfaces. Rotary-impact drills may be used for installing expansion anchors in concrete. Do not use powder explosion type units.

Do not install underground conduit until the area has been brought to final earth grade. Give careful attention to the vertical and horizontal alignment of the conduit to provide the smoothest installation.

(F) Wiring Methods

Do not pull wire through a conduit system until the system is complete and has been cleaned. Use approved wire pulling lubricants. Pull wires into conduit at a slow steady pace and give careful attention to assure that no wire is damaged.

Color code all conductors per the NEC (grounded neutral- WHITE, grounding - BARE or GREEN) and use phase conductors which are BLACK and RED. Approved marking tape, paint, or sleeves may be used in lieu of continuous colored conductors for No. 8 AWG and larger. Do not mark a white conductor in a cable assembly any other color. However, a white, red, or black conductor may be stripped at all accessible points and used as a bare equipment grounding conductor.

Joints, taps, and splices will only be permitted at locations indicated on the plans and by the following methods.

Locations in junction boxes and bases of standards:

(1) Cut and remove the insulation only as far as necessary to make a secure mechanical and electrical connection. Use connectors which are a removable type (split-bolt, set screw, wire nut, etc.) and covered with self-vulcanizing rubber tape applied in half-lap layers, to give a smooth covering of not less than 2 times the thickness of the original insulation. Over the rubber tape, apply half-lap at least two layers of vinyl plastic tape. Use rubber tape which is a self-fusing type putty in tape form that can be wrapped, stretched, or molded around irregular shapes for smooth insulation build-up. Use vinyl plastic tape that is 7 mil ultraviolet, abrasion, moisture, alkali, acid and corrosion resistant.

(2) Install a manufactured mechanical or compression connector with factory made waterproof insulating boots in accordance with procedures and using tools as specified by the manufacturer.

(G) Grounding Electrodes

Install grounding electrodes at each junction box, and control system as shown on the plans. Where installed in earth, drive them flush with the ground after installation of the clamp and conductor.

(H) Equipment Mounting

Mount equipment securely at locations shown on the plans in conformance with the dimensions shown and make vertically plumb and level. Install fasteners as recommended by the manufacturer and space evenly. Utilize all mounting holes and attachment points for attaching enclosures to structures.

(I) Concrete Foundations

Use concrete foundation dimensions verified in accordance with the details shown on the plans or approved drawings. Construct concrete foundations in accordance with Section 825. Use class A concrete, meeting the requirements of Section 1000 and reinforcing steel which conforms to the requirements ASTM-A615, Grade 60, Deformed .

Perform foundation excavations that conform to the applicable requirements of Section 410. Construct the sides of the excavation to conform as nearly as practicable to the required dimensions. Place concrete against undisturbed soil unless otherwise permitted. If large discontinuities in the required configuration of the excavation are created by the removal of boulders or due to any other causes, backfill the excavation and compact as provided for in Section 410 . Re-excavate the foundation to the proper dimensions. If rock or boulders are encountered during the excavation, they shall be removed to a depth sufficient to obtain the stability necessary to support the structure for the design loads.

Form foundations with prefabricated cardboard forms down to 6" minimum below top of ground. Concrete shall be cast against undisturbed soil. If temporary shoring is required in conjunction with the excavation, smooth steel pipe of the specified diameter shall be installed and retracted as concrete is cast against undisturbed soil. If permanent casing, either smooth or corrugated, is used it shall be pushed or screwed into undisturbed soil and then cleaned of debris prior to casting concrete. No water shall be allowed to accumulate before or during the casting.

Set the top of foundation elevation relative to the surrounding ground surface as shown on the plans. Chamfer corners at the top of foundation. Give exposed vertical concrete surfaces an ordinary surface finish and exposed horizontal concrete surfaces a float finish. Use galvanized steel hardware cloth or welded wire fabric, between the top of foundation and bottom of mounting base if indicated on the plans or other sections of the Specifications. Attach hardware cloth to anchor bolts with size AWG 14 copper wire or small gage galvanized wire.

Do not erect standards before test cylinders representing the foundation concrete have attained a minimum compressive strength of 3000 psi. Do not remove forms until the concrete has properly cured, and in no case less than 24 hours after the concrete has been placed.

Arrange anchor bolts symmetrically about the center of the foundations, brace securely, and hold in the proper position and alignment. Install electrical conduits of the size and number required by the circuits in the concrete as shown on the plans. The number of conduits shown on the plans is a guide only, with the actual number required being based on the number of circuits to be installed at the foundation being constructed; however, in no case should less than 2 conduits be installed.

To avoid vehicle undercarriage snagging of any substantial remains of a breakaway support (when it is broken away), the edge of the foundation or top of anchor bolt should not extend more than 4" above a 60" chord aligned radially to the centerline of the highway, and connecting any point within the length of the chord on the

ground surface on one side of the foundation to a point on the ground surface on the other side.

1400-5 INSPECTIONS

Maintain responsibility for having each electrical system inspected and approved by the electrical inspector having jurisdiction in the area in which the systems are located. Furnish written verification, prior to the final acceptance of the project, that the inspector has approved the electrical systems. Inspection by local authorities will neither eliminate nor supersede the inspection by the Engineer to ensure compliance with the contract.

Comply with all local ordinances and regulations. Apply for and obtain all permits and/or licenses required by local regulation.

Have all work inspected and approved before concealment. An inspection will be made during the progress and after the work has been completed. It will also include an inspection made at night to determine the optical qualities of each luminaire. Adjust all luminaires having unsatisfactory qualities as directed.

Provide the necessary personnel and equipment for aiming luminaires during nighttime inspections by the Engineer.

1400-6 PERFORMANCE TESTS

Prior to acceptance, operate the lighting system, including automatic control equipment and all other apparatus, without interruption or failure attributable to poor workmanship or defective material for 2 consecutive weeks. All lights and equipment will be inspected for normal operation. Make all necessary repairs or replacements.

Conduct the performance test at the same time for all lights which are energized from the same utility company service point.

Performance tests of individual circuits or groups of lights will not be acceptable.

Arrange with the power company to provide the electric power necessary. Separate payment will not be made for labor, materials, equipment, and incidentals required for performing the tests.

After all wiring has been installed and connected in the proposed permanent manner, but prior to the above operation period, give each feeder circuit conductor an insulation resistance test by the Engineer. The insulation resistance for each conductor shall exceed 5 megaohms after charging for 30 seconds at 500 VAC or 1000 VDC.

If the insulation resistance test of any conductor indicates a value of less than 5 megaohms, locate the fault. If the fault is in a conductor between terminal connections, replace the conductor. If the fault is at a terminal connection, repair or replace the terminal device as directed. Have satisfactory insulation resistance on all wiring prior to beginning the 2 week operation test.

1400-7 IDENTIFICATION

Identify each component of the lighting/electrical system as indicated on the plans. Use a method of identification which includes an approved paint, adhesive label, heat shrink label or embossed concrete. Label conductors on components requiring identification at

each terminal, circuit breaker, light standard, high mount standard, control system, junction box, and underpass panel.

Label each circuit conductor at each terminal and access point with the circuit number indicated on the plans.

Identify light standards and high mount standards by the control system and location number indicated on the plans. Put the identification on the front side of the standard facing the traffic at a height of 6 feet above ground level. Identify control systems and underpass panels on the exterior of the front panel.

1400-8 LOCKS AND KEYS

Supply all access doors to control cabinet enclosures with locks that meet the Engineer's approval. Key all locks alike and furnish 8 keys to the Engineer.

1400-9 ELECTRICAL SERVICE

Coordinate all work to ensure that electrical power of the proper voltage, phase, frequency, and ampacity is available to complete the project. Contact the utility company, make application, pay all deposits and other costs to provide necessary electrical service. The Contractor will be reimbursed for the actual verified cost of any utility company charges.

The Engineer will provide authorization to the Contractor for electrical service to be obtained in the name of the Department and for the monthly power bills to be sent directly from the utility company to the Department. The Department will be responsible for direct payment of monthly power bills received from the utility company.

1400-10 TERMINOLOGY

The terms *high mast* and *high mount* are used synonymously in the contract.

The term *by others* means work to be accomplished and paid for under contract items other than those clearly pertaining to the work specified or shown. Work by others may be included in this contract for the Contractor to provide, or it may be provided under another contract or by someone other than the Contractor.

Abandon means that the materials will not be used in the final completed form of the work. Remove all abandoned materials from the project or terminate at least 18" below subgrade so that they will not be in conflict with the finished project.

1400-11 CONSTRUCTION PHASING

Accomplish lighting work along with other roadway construction in the appropriate phases as indicated in the Traffic Control Plans and these Specifications.

1400-12 MEASUREMENT AND PAYMENT

There will be no direct payment, except where specifically noted in the Subarticle 1400 - 3(C) Samples and Subarticle and 1400-9 Electrical Service for the work required in the preceding sections of this division. Payment of the contract unit prices for the various items in the contract will be full compensation for all work required.

SECTION 1401
HIGH MOUNT STANDARD

1401-1 DESCRIPTION

Furnish and install a high mount standard 75' or greater in height with a top-latched lowering device and portable drive unit including the drive, winch, wiring, cables, brackets, hardware, transformer, power cord, storage case, and operating manuals.

1401-2 MATERIALS

(A) High Mount Standard

The standard may be either a multisided or round tubular member. Furnish 8 copies of completely detailed drawings and 1 copy of the complete design computations for each height of standard for approval prior to fabrication. Have the drawings show all details relating to pole, access hole, base, anchorage, and lowering device. Show references to ASTM specifications or to other material specifications for each type of material used on the drawings. Make sure that all drawings are clearly identified with a drawing number and signed and dated by the manufacturer's authorized representative.

Show clearly full and complete information regarding location, type, size, and extent of all welds on the drawings. For groove welds, indicate the particular detail and process to be employed in production of the work. For prequalified joints, use of the Bridge Welding Code letter classification designation of the joint (B-Lzb-S etc.) will satisfy this requirement.

Note the total weight in pounds on the drawings for each component and the total assembly.

The Contractor's attention is directed to the fact that it will take approximately 10 weeks to secure approval after submission of the complete drawings and computations.

Have the design of the support including base plate and anchorage conform to *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, and the Interim Specifications* valid at the time of letting. Fatigue Category I shall be used in design. The welding design and fabrication shall be in accordance with Article 1072-20. The support is to be designed for the wind velocity shown on the plans.

Fabricate the support in accordance with the details shown on the approved shop drawings and with the requirements of the Specifications.

Fabricate support steel and hot-dip galvanize it after fabrication has been completed.

Test all base plate to upright welds using magnetic particle testing (MPT) prior to galvanizing. All base plates shall be tested at 100%.

Have the galvanization conform to ASTM A153 for fasteners and to ASTM A123 for other structural steel.

Have all welding of steel components conform to the *Standard Specifications* with the following exception. Partial penetration longitudinal groove welds on shaft sections having a minimum throat of 60% of the thickness of material being joined will be acceptable provided the qualification requirements of the Bridge Welding Code are met. However, full penetration will be required on longitudinal groove welds within 6 " of circumferential welds and in areas where a shaft section telescopes over another shaft section. No field welding of any part of the assembly will be permitted.

Allow easy access to all components in the base of the standard with a hand hole with a hinged and lockable door. Allow for opening of the door without the use of special tools or wrenches. Make the hand hole large enough for removal of the circuit breaker and the hoist gearbox and winch assembly (minimum 9" x 18"). Make the door hinge and lock mechanism sturdy enough to prevent vandalism and to prevent freeze-up or binding due to corrosion or too tight fit. Achieve locking with a conventional pad-lock. Built in locks or latching mechanism for the door will not be acceptable.

(B) Lowering Device

Furnish 8 copies of completely detailed drawings of the lowering device with manuals describing the assembly, erecting and operating procedures. Include precise instructions on stringing the cables and leveling the carrier ring.

On each high mount lighting standard have a device to lower the luminaires from the operating position at the top of the standard to a service position approximately 3' above the base of the standard. Include on the device a head-frame, top latching carrier ring, and winch assembly. Design the lowering device for the number of luminaires as shown on the plans, each weighing and each having a projected area in accordance with Section 1403.

Mount the head frame on the standard with a slipfitter and set screws and have sheaves or rollers for the lifting and power cables. Also have sockets to automatically secure the carrier ring at the top in the raised position, and have a hood on the entire assembly for protection from the weather. Attain latching and unlatching by alternately raising and lowering the carrier ring. Use sheaves that are non-corrosive materials with bronze bushings and stainless steel shafts. Provide suitable retainers to assure that the cables stay in correct position.

Have slipfitter tenons equally spaced for mounting the luminaires on the carrier ring. Have the carrier ring automatically latched to the head frame when raised into position by suitable pins and sockets which will prevent the luminaires from swaying, turning, vibrating, or otherwise moving out of proper position. Include on the carrier ring spring loaded roller arms to guide the ring during raising and lowering operations. Use springs made of stainless steel and rollers made of nylon. Mount a weatherproof junction box on the ring for connection of individual luminaire circuits to the electrical power supply cable. Include in the junction box a flanged inlet for connection of the power supply cable. Use an inlet and cable connector which is of the locking type and weatherproof.

Use a winch assembly that is a self-locking worm gear type designed for operation with a portable power unit. Have the winch drum automatically reverse the lay of the hoist cable and prevent uneven build-up or tangling.

Provide a terminator for joining the hoist cable and 3 suspension or lifting cables. Provide the means to compensate for variations in the lengths of the 3 lifting cables. Use hoist and lifting cables made of stranded high strength stainless steel extra flexible aircraft type. Use hoist and lifting cables that meet structural requirements of Military Specification MIL-W-83420D and have the center strand not protruding more than .06 " after the cable is cut.

Use a power supply cable that is rated for suspension and has approved strain relief fittings at each end. At the base of the standard, provide a locking type plug with waterproof cover to connect to a short power supply cable stubbed from the circuit breaker panel.

(C) Portable Drive

Supply a portable drive unit with a heavy duty reversible electric motor with torque limiter type drive of adequate capacity, complete with a grounding type cord, suitable couplings for attaching the unit to the winch assembly, and a sturdy storage container for the unit and accessories involved. Provide one portable drive unit for the completed project. Provide a drive unit with a lever switch controller with clearly marked UP and DOWN positions. Connect the controller to the drive unit with a cord of sufficient length to let the operator stand a minimum of 15' from the base of the high mount during lowering or raising operations.

Shop assemble the portable drive unit and remove all rough edges. Use mounting or adjustment bolts which allow hand tightening.

Provide a complete unit that includes a durable metal storage case with all equipment and instructions for operation. Use a case which is the approximate size as shown on the plans, has a continuous hinge on the lid, and has sturdy carrying handles on each end. Furnish a hasp with padlock as shown on the plans. Construct the case with 16 gauge formed and welded steel with bracing to prevent warping. Paint the inside and outside with a durable quality paint. Provide an identification label as noted in the plans on the storage case.

(D) Circuitry

Install an enclosed circuit breaker in the base of the high mount standard. Use a breaker which is rated 480 VAC, 2 pole, 30 ampere unless noted otherwise on the plans.

Provide a supply cord originating from the circuit breaker with a female twist lock connector for testing the luminaires at ground level, during lowering operation using the portable drive unit, and when in the raised position during normal night operation.

Provide a junction box mounted on the lowering ring with a flanged inlet to accept the female twist lock connector from the supply cord. Use plugs, flanged inlets, and

connectors for the supply cable and drive unit which allow grounding and are weatherproof.

Install the wiring for each high mount luminaire separately from the luminaire to the junction box. Series or loop circuitry is not allowed.

Provide a transformer, branch circuit breaker, and GFCI receptacle as a power source for the portable drive.

Provide an equipment grounding conductor in the supply cable. Include an equipment grounding conductor in the wiring for each luminaire.

(E) Operation

Demonstrate the operation of the lowering device by raising and lowering the carrier ring with luminaires a minimum of 5 times for each high mast. Include in this demonstration latching and unlatching at the top and connection of test cables at the bottom. Twisting of the cables, failure of the carrier ring to latch or unlatch, unlevelness of the carrier, or hang-up of guide arms will be sufficient reason not to accept the lowering device.

1401-3 CONSTRUCTION METHODS

Use suitable blocking and slings to prevent warping of the high mount standard during storage and transportation. Assemble all parts and string all cables in strict accordance with the manufacturer's instructions.

Make sure that the top of the standard is not out of plumb more than one half of one percent of its height. Tighten anchor bolts according to the Engineer’s directions.

Include assembly instructions and any special tools, blocks, washers, etc. in the portable drive storage case.

Remove all dirt, stains, marks, etc. prior to erecting the high mast.

1401-4 MEASUREMENT AND PAYMENT

High Mount Standards with lowering devices to be paid for will be the actual number of standards which have been installed and accepted. High mount lighting standards with lowering device, measured as provided above, will be paid for at the contract unit price each for _____ *High Mount Standard* of the appropriate height.

Portable drive units with storage cases to be paid for will be the actual number of portable drive units that have been furnished and accepted. Portable drive units with storage case, measured as provided above, will be paid for at the contract unit price each for Portable Drive Unit.

Payment will be made under:

Pay Item	**Pay Unit**
_____ High Mount Standard	Each
Portable Drive Unit	Each

SECTION 1402
HIGH MOUNT FOUNDATION

1402-1 DESCRIPTION

Construct a concrete foundation for a high mount standard 75' or greater in height, including concrete, reinforcing steel, placing of the anchorage assembly, conduits, forms, shoring, excavation and backfilling.

1402-2 MATERIALS

Use materials which are new and in accordance with Subarticle1400-4(I).

1402-3 CONSTRUCTION METHODS

Construct foundations in accordance with Subarticle 1400-4(I), and as shown on Roadway Standard Drawing 1402.01. Either the Engineer or the Contractor may choose to construct foundations as specified under Site Specific High Mount Foundation described below. The Standard Drawing is based upon the following assumed soil parameters:

Total Unit Weight = 120 pcf
Friction Angle = 30 degrees
Cohesion = 0 psf

The groundwater elevation is assumed to be at a depth of 7 feet below the ground surface and the ground surface is assumed to be level. If the Engineer determines these assumed conditions are not applicable to a specific site, or the Contractor chooses not to use the Standard Drawing, a site specific foundation design is required.

Arrange anchor bolts symmetrically about the center of the foundations, brace securely and hold in the proper position and alignment. Reinforcing steel shall be hooked or bent per ACI code, and tied sufficiently to retain its proper shape during concrete placement. Provide PVC conduits in the foundation concrete as shown on Roadway Standard Drawing 1402.01.

(A) Site Specific High Mount Foundation

If the assumed soil parameters are not applicable to a specific site, the Engineer may require a site specific foundation design. Conditions requiring a site specific design include but are not limited to very soft or loose soil, muck (generally, standard penetration test (SPT) blow counts per foot less than 4), weathered rock or hard rock (generally, SPT refusal). The Engineer may also require a site specific design if the groundwater elevation is shallower than 7 feet or the ground surface is steeper than 2:1 (H:V). If the Engineer requires a site specific design, rough grade the site (within 3 feet of final grade) and ensure accessibility for a drill rig. Notify the Department when the site is accessible. Within four weeks of notification, the Department will perform a subsurface investigation and provide a site specific foundation design.

Payment will be made for the actual quantity of concrete required for high mount foundations based upon the site specific foundation design provided by the Department.

In lieu of using Roadway Standard Drawing 1402.01, the Contractor may choose to provide a site specific foundation design. If the Contractor chooses to provide a site specific design, perform a subsurface investigation, and submit the site specific foundation design to the Department for approval, in accordance with the requirements listed below. If the Contractor provides a site specific design, payment will be made for the plan quantity of concrete for high mount foundations shown in the Standard Drawing, and no additional payment will be made for the costs of the subsurface investigation and foundation design.

Subsurface Investigation:

Perform a boring at each high mount foundation location and provide boring data on an NCDOT Standard Boring Log form. Download this form from the NCDOT ftp site. A licensed geologist or a professional engineer licensed in the State of North Carolina and employed by an NCDOT Highway Design Branch pre-qualified Geotechnical Engineering Firm shall seal each boring log. Use only an NCDOT Highway Design Branch pre-qualified Geotechnical Engineering Firm to conduct the subsurface investigation. Perform the investigation only after rough grade (within 3 feet of final grade) is achieved.

Locate the boring within 3 feet of the center of the high mount foundation. Drill the boring a minimum of 5 feet deeper than the foundation depth required by Roadway Standard Drawing 1402.01. Conduct Standard Penetrating Tests at 1 foot, 2.5 feet, 5 feet, 7.5 feet, 10 feet, and every 5 feet after 10 feet below the rough grade, in accordance with ASTM D-1586. A boring may be terminated above the minimum depth required (10 feet below the foundation elevation), if one of the following conditions occur: (a) a total of 100 blows have been applied in any 2 consecutive 6" intervals; (b) a total of 50 blows have been applied with less than 3" penetration.

Foundation Design

Use only an NCDOT Highway Design Branch Pre-Qualified Geotechnical Engineering Firm to provide a site specific foundation design. A North Carolina Licensed Professional Engineer shall seal all design calculations, drawings and recommendations. Submit 8 copies of the subsurface investigation and foundation design to the Engineer for approval and allow 30 days for review.

Design foundations in accordance with the wind zone load shown on the plans. Provide reinforced concrete design in accordance with Section 13.6.2, allowable stress design method, of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals* (including interims).

Consider sloping ground in the design, if applicable. Design the foundations to provide horizontal movements of less than 1/2" at the top of the foundation.

Provide a 3 foot level work area around each high mount foundation with cut and fill slopes extended to final grades as directed.

1402-4 MEASUREMENT AND PAYMENT

High mount foundations will be measured and paid for as the number of cubic yards of concrete necessary to construct foundations in accordance with the dimensions authorized by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
High Mount Foundations	Cubic Yard

SECTION 1403
HIGH MOUNT LUMINAIRES

1403-1 DESCRIPTION

Furnish and install luminaires, including lamps and ballasts, for high mount standards 75' and greater in height.

1403-2 MATERIALS

Provide luminaires consisting of a die cast aluminum ballast housing a cast aluminum slipfitter housing, and cover which do not weigh more than 65 lbs. and have an effective projected area not more than 2.0 square feet.

Provide ballast capable of operating a high pressure sodium lamp from a source with a nominal voltage as shown on the plans with a tolerance of ±10%. Provide luminaires with IES Distribution: Medium, Cutoff, Type V, and the wattage shown on the plans. Provide glare shields for each luminaire, and position to eliminate spill light outside the right of way. NCDOT will evaluate photometric data for submitted luminaire to ensure adequate light output from the fixture.

Provide slipfitter housing suitable for use with 2" horizontal mounting, adjustable for leveling, and which secures the mounting assembly to prevent twisting of the luminaire about the bracket.

Use an optical assembly which contains a porcelain enclosed mogul socket with spring loaded center contact and lamp grips and has an insulated outboard lamp grip to protect the lamp from damage due to vibration. Position the socket for base up lamps.

Provide complete photometric, assembly and electrical data for each type luminaire proposed. Include in the data candlepower distribution and isofootcandle graphs, assembly drawings with replacement part numbers, and electrical schematic with ballast input/output voltage/amperage/wattage ratings.

1403-3 CONSTRUCTION METHODS

Lamp all high mount fixtures just prior to testing the system. Mark the date of installation with the code on the base of each lamp.

Level and secure each luminaire in all directions. Careful attention should be given to aim the main beams and house-side outputs of all asymmetrical units in the direction indicated on the plans. Securely terminate the wiring for each luminaire and include an equipment grounding conductor to bond the housing to the supply cord grounding conductor.

1403-4 MEASUREMENT AND PAYMENT

High mount luminaires ___ of the appropriate wattage and type will be measured and paid for as the actual number of luminaires of each size and type that have been installed and accepted.

Payment will be made under:

Pay Item	**Pay Unit**
High Mount Luminaires _____	Each

SECTION 1404
LIGHT STANDARDS

1404-1 DESCRIPTION

Furnish and install light standards less than 75' high complete with bracket arm(s), including the impact attenuation device (breakaway base) as shown on the plans.

1404-2 MATERIALS

Provide a standard that meets the design criteria of the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals,* and the Interim Specifications valid at the time of letting. The support is to be designed for the wind velocity shown on the plans.

Provide a standard designed to support an ellipsoidal shaped luminaire, which has a center of gravity not more than 18" from the end of the support, with a minimum weight and projected area and a bracket arm length as indicated in the contract.

Make sure that each lighting standard has a grounding lug in the standard near the base or in the transformer base. Locate it within 6" of the hand hole.

Deliver standards with a smooth uniform finish, free of disfiguring scratches or dents, and with suitable protection for further handling during erection.

Wrap or package each light standard as recommended by the manufacturer to prevent damage during shipping and handling. Repair or replace, at the option of the Engineer, any standards with abraded finishes or other damage.

Furnish aluminum or steel standards and arms; however, use the elected material throughout the project.

Galvanize steel components after fabrication. Use galvanization which conforms to the requirements of ASTM A123 for tubes, plates, and bars, and to ASTM A153 for hardware.

Use connecting bolts, washers and nuts compatible with the transformer base as recommended by the light standard manufacturer and which comply with the contract.

Use anchor bolts, washers, nuts and shims which comply with the Specifications and details shown in the plans as recommended by the light standard and transformer base manufacturer(s).

Furnish anchor and/or connecting bolt covers and pole top caps with standards as indicated on the plans.

Provide pole hardware - Nuts, bolts, and washers for aluminum standards from 18-8 stainless steel or aluminum alloy 2024-T4. Provide nuts, bolts, and washers for steel standards from 18-8 stainless steel or steel conforming to ASTM A307. Submit drawings for approval, which show material specifications for each component.

Use bracket arms for each standard, which are the length shown on the plan sheet and of the same material as the standard.

Provide light standards with an approved impact attenuation feature (breakaway base) that complies with *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* and one of the following descriptions.

(a) A cast aluminum transformer base

(b) A frangible base insert or adapter

(c) A breakaway or progressive shear base

(d) A slip base

Use the same type of breakaway device throughout the entire project.All breakaway devices shall be FHWA approved. Include in the device protection for wiring and conduit at the base of the standard, in the form of a special heavy-formed material secured in place.

1404-3 CONSTRUCTION METHODS

Locate and number the light standards as shown on the plans.

Do not lay the standards on the ground, without proper blocking and protection to prevent warping and discoloration. Protect them from damage by other construction work, including landscape mulching and fertilizing operations.

Securely mount the standards on the anchor bolts, and plumb up with nuts torqued according to the manufacturer's recommendation.

Mounting height is defined as vertical distance from luminaire to surface of pavement of heaviest traveled lane in area illuminated by the luminaire. A tolerance of ±1'-6" from the required mounting height will be permitted. If this tolerance is exceeded, furnish and install an acceptable standard within this tolerance.

1404-4 MEASUREMENT AND PAYMENT

Light standards, ___ will be measured and paid for as be the actual number of light standards with arm assemblies of each appropriate mounting height and bracket arm type and length that have been installed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Light Standards, _____	Each

SECTION 1405
STANDARD FOUNDATION

1405-1 DESCRIPTION

Furnish and install all materials necessary to construct concrete foundations for light standards, including concrete, reinforcing steel, anchor bolts, nuts, forms, excavation, and backfilling.

1405-2 MATERIALS

Use new materials that are in accordance with Subarticle 1400-4(I).

1405-3 CONSTRUCTION METHODS

The foundation design shown on the plans is based upon placing foundations into undisturbed soil or fill of at least medium density. The Engineer will stake each location and determine the top of foundation elevation unless indicated differently elsewhere in the Specifications. The foundation type and depth will be determined by the plan details in accordance with the final soil and slope conditions at each location.

Pour the pedestal portion concrete monolithic with the barrier portion, on light standard foundations that are an integral part of a barrier. Construct the barrier portion as specified in other sections of the contract, and continuous through the foundation. Coordinate construction of foundations in median barrier with the signing plans to avoid conflict with overhead sign structure foundations.

Where rock creates a conflict with construction of the standard foundations, an alternate foundation may be constructed if approved.

1405-4 MEASUREMENT AND PAYMENT

Standard foundation ___ will be measured and paid for as the actual number of foundations for each appropriate height and type of standard, that have been completed and accepted.

The quantity of bedrock foundations to be paid for will be the actual number of alternate foundations for bedrock locations for standards of the appropriate type, which have been installed and accepted.

Alternate foundations for rock locations will be paid for at 1.5 times the contract unit price each for Standard Foundations, _____ of the appropriate type that would have been installed if rock had not been encountered.

The requirements of Article 104-5, which pertain to adjustments in contract unit prices for overrunning or underrunning pay items, will not be applicable to pay items covered by this section.

Payment will be made under:

Pay Item	Pay Unit
Standard Foundation, _____	Each

SECTION 1406
LIGHT STANDARD LUMINAIRES

1406-1 DESCRIPTION

Furnish, install, and place into satisfactory operation, luminaires on the bracket arm complete with all lamps, ballasts, wiring inside standard from circuit conductors to luminaire, in-line breakaway fuses and ground wiring at the pole on light standards less than 75' in height.

1406-2 MATERIALS

Use luminaires that are ellipsoidal shaped with a center of gravity not more than 18" from the end of the luminaire support, do not weigh more than 55 lbs., and have a maximum effective projected area of 1.2 square feet.

Use luminaires that are UL listed and labeled.

Use luminaires that have a lens holder latch on the street side and ballast, plug-in starter, and capacitors mounted on a removable door. The removable door shall have a continuous hinge bar to prevent door opening due to vibration. The luminaire shall have a slipfitter for 2 mounting brackets, with a stainless steel shield ring, a 4-bolt adjustable pipe clamp and leveling steps for tilt adjustment. Use luminaires with a replaceable mogul base lamp socket adjustable in both vertical and horizontal directions, capable of producing the specified IES distribution pattern. Third party certification for photometric data shall be provided upon request. Provide a heat resistant tempered flat glass lens, and a reflector with a hard glasslike highly reflective corrosion resistant finish. Provide a filter between the lens and reflector tub.

Use luminaires that have an internal high power factor ballast of the regulated type, capable of operating from a multi-wire circuit and energize a high intensity discharge lamp. The luminaire shall have a barrier between the ballast compartment and the reflector tub. Transformer windings shall be covered and protected. Lamps shall operate satisfactorily with a line voltage variation of ±10%. Provide a ballast pre-wired to the lamp socket and terminal board, requiring only the connection of the power supply leads to the terminal board.

Use luminaires with a wattage rating, voltage rating, lamp type, and light distribution as indicated on the plans.

1406-3 CONSTRUCTION METHODS

Date lamps using the date code on the base and install just prior to the system being ready for testing.

Level luminaires using leveling pads on the luminaire enclosure. Adjust any luminaires, as directed, to give optimum illumination distribution.

1406-4 MEASUREMENT AND PAYMENT

Light standard luminaires ___ will be measured and paid for as the actual number of luminaires of each appropriate size and style that have been installed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Light Standard Luminaires _____	Each

SECTION 1407
ELECTRIC SERVICE POLE AND LATERAL

1407-1 DESCRIPTION

Furnish and install wood service poles, wire, conduit, bushings, fittings, connectors, meter base, and weatherhead from the service point to a control system.

1407-2 MATERIALS

Provide service poles which are Class 4 and in accordance with Subarticle 1082-3(F). Provide poles with preservative treatment in accordance with Subarticle 1082-4(G).

Use stranded copper Type USE conductors installed in rigid galvanized steel conduit sized as shown on the plans for the service lateral.

1407-3 CONSTRUCTION METHODS

Dig holes large enough to permit the proper use of tampers to the full depth of the hole. Place backfill in the hole in 6 " maximum layers and thoroughly tamp. Place surplus earth around the pole in a conical shape and pack tightly to drain water away.

Set the pole to a depth of 5'-6" minimum unless shown otherwise on the plans. When utility power is available from outside the right-of way, locate the service pole a maximum of 10 feet inside the right-of-way. The utility company will install overhead conductors from their facilities. Install an underground service lateral from the service pole to the control system. If the utility company provides a pad mount transformer, allows attachment of the riser and weatherhead to their pole, or provides underground service from their pole, then any proposed service pole will be deleted from the contract.

Make connections at the service head at the bottom of the drip loop to prevent siphoning of water through the cable.

Provide for a meter in accordance with the requirements of the utility company's condition of service.

A meter base for a self-contained meter may be mounted on the service pole or back of the control enclosure as indicated on the plans. A current transformer (CT) cabinet and meter base may be mounted in either location if requested by the utility company.

1407-4 MEASUREMENT AND PAYMENT

Electric service pole ___ will be measured and paid for as the actual number of the appropriate length and class electric service poles that have been installed and accepted.

Electric service lateral ___from service pole to control panel will be measured and paid for as the actual number of linear feet of the appropriate size and type service lateral that has been installed and accepted. Measurement will be along the longest conductor from electrical terminal to electrical terminal.

Payment will be made under:

Pay Item	**Pay Unit**
Electric Service Pole _____	Each
Electric Service Lateral _____	Linear Foot

SECTION 1408
LIGHT CONTROL SYSTEM

1408-1 DESCRIPTION

Furnish and install an entire control system, including enclosure, control panel, photocell, switches, contactors, breakers, terminal blocks, wiring, concrete foundation, and lightning arrester. The control system will be standard electrical components in a stainless steel enclosure mounted on a metal pole with a concrete foundation as shown in the contract.

1408-2 MATERIALS

Provide concrete foundations and wire in accordance with the applicable Sections of the Specifications.

Use a piece of rigid galvanized steel conduit, embedded in concrete as shown on the plans for mounting the control system

Provide a NEMA type 3R stainless steel enclosure with external stainless mounting flanges, drip shield, back panel and continuous hinge door with a print pocket. Provide a door closing mechanism interlocked with a flange mounted operator handle to prevent the opening of the door with the service circuit breaker in the ON position, except by use of safety override devices.

Provide an enclosure approximately 36" high by 30" wide by 10" deep unless noted otherwise on the plans.

Provide only openings necessary for the entrance of conduits as shown on the plans. Do not use knockouts. Have the enclosure conform with NEC Article 312 and mount the

devices so the NEC clearances will be provided, except use 1 1/2" where not specified is noted in the tables for min. wire bending space.

Use galvanized slotted steel framing channel with straps and bolts, sized as shown on the plans for the mounting brackets and hardware for attaching the enclosure to the pole. Use galvanized finish on the brackets and hardware and coat all field cuts or scratches with organic zinc repair paint.

Provide a neutral bar, bonded to the panel and with sufficient box lug type terminals to accept the required number of wires.

Mount components to the back panel with manufacturer supplied mounting brackets or permanently attached screw studs.

Use a service circuit breaker providing an interrupting rating of 22,000 amperes minimum. Provide breakers which are thermal magnetic molded case permanent trip type. Provide multi-tap solderless load side box lugs, or distribution terminal blocks of the appropriate size. Use insulating material approved for NEMA 3R applications. Provide a breaker with a voltage and amperage rating as indicated on the plans.

Provide a control circuit breaker which is rated 240 VAC phase to ground, has a current interrupting capacity of 5000 amps minimum, and is a single pole, open type with a high magnetic trip setting of 20 amps.

Provide 3 60 ampere, 4 pole mechanically held contactors that have coil clearing contacts and coil voltage rating as indicated on the plans. Contactor latching with hooks or semi-permanent magnets is unacceptable.

Use a control relay rated 240 VAC with one normally open contact and one normally closed contact and has a continuous load rating and inductive make rating greater than that required by the mechanically held contactor. Use a coil rated for 240 VAC 60 Hz.

Use a selector switch which is a heavy duty 3 position maintained contact unit in a surface mount (NEMA 1) enclosure with a legend consisting of On-Off-Auto and having continuous current rating of 10 amperes at 240 VAC for the contacts.

Use feeder circuit breakers which are rated 14,000 amps minimum interrupting capacity and have an open type molded case with a non-adjustable thermal magnetic trip setting of 50 amps maximum, and as noted in the plans.

Use a photo-control which is the encapsulated cadmium-sulfide type, suitable for use on an operating voltage range of 105-285 volts and nominal control voltages of 120, 208, 240, and 277 volts. Have the control rated for 1000 watts resistive load or 1800 volt-amperes of inductive load. Set the light-level within a range of 1.0 to 3.0 footcandles. Have internal protection for surges in excess of 2000 volts peak for the control. Mount a receptacle directly to the top of the enclosure with a weatherproof fitting. Use controls and receptacles which conform to IEEE Standard C136.10-1996, *Locking-type photocontrol devices and mating receptacles-physical and electrical interchangeability and testing* for roadway lighting equipment.

Use a lightning arrester of the thyrite type, designed to contain and snuff out an arc of 10,000 amps. Install the arrester on the load side of the service breaker.

Use terminals and lugs rated for the connection of the appropriate size copper conductors All conductors shall be made of copper and neatly wrapped in bundles or run in plastic raceways.

Perform all galvanizing in accordance with Section 1076.

Provide a drawing to scale showing the location, brand and catalog number of each component of the control system for approval.

The completed light control system shall be marked "Suitable for Use as Service Equipment", in a prominent location in the enclosure, in accordance with NEC Article 230.66. If the control system is not made in a certified UL 508 Panel Shop, a third party, recognized by the Department of Insurance as having the authority, shall label the control systems.

1408-3 CONSTRUCTION METHODS

Construct the foundation for the control system as shown on the plans with the top of the foundation 3" above finished grade.

Fasten the enclosure to the pole by means of a galvanized bracket assembly as shown on the plans. Make all cuts square and remove all rough edges. Have mounting holes match existing mounting holes of the enclosure.

Arrange all conduits entering the enclosure in a neat symmetrical manner and extend directly downward into the foundation. Install all conduits shown on the plans. Stub and cap spare conduits for future circuits underground.

Apply 2 coats of organic zinc repair paint to all field cut metal and conduit threads.

1408-4 MEASUREMENT AND PAYMENT

Light control equipment (type) will be measured and paid as the actual number of the appropriate type light control systems that have been completed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Light Control Equipment, (Type) _____	Each

SECTION 1409
ELECTRICAL DUCT

1409-1 DESCRIPTION

Furnish and install electrical duct including materials, equipment, and labor for trenching, backfilling, and jacking or boring so that electrical circuits may be easily installed at locations shown on the plans.

1409-2 MATERIALS

Use electrical duct that is non-metallic rigid PVC (Polyvinyl Chloride) heavy wall conduit, HDPE (High Density Polyethylene) Standard Dimension Ratio (SDR) 13.6 or rigid galvanized steel conduit, in accordance with Section 1098-4.

1409-3 CONSTRUCTION METHODS

Duct is a passageway for electrical circuits. Install ducts in accordance with NEC requirements for an approved raceway. Locate the duct as shown on the plans and at a minimum depth of 30" unless indicated otherwise on the plans. Locate bore pits outside the clear zone, as defined in the *AASHTO Roadside Design Guide*.

The lengths noted on the plans are only typical. Make actual field measurements to place the ends of the duct at the required locations. Make up lengths of duct with the minimum number of pieces joined together with couplings and solvent as recommended by the manufacturer.

Clean and plug the duct in accordance with Subarticle 1400-4(E).

Plug the duct with oakum or duct seal after feeder circuits in conduit are extended through duct.

Place buried duct in a trench with essentially vertical walls and only wide enough for easy installation of the duct. Tunneling by hand or other approved methods may be required to install duct beneath existing walks or paved ditches. Perform backfilling in accordance with Article 300-7.

Jacked duct may be installed by either of the following methods at the Contractor's option, when placement of electrical duct beneath pavement by jacking is noted on the plans.

(A) The duct may be pushed beneath the pavement through earth without prior construction of an opening.

(B) A bored opening not more than 1" larger than the outside diameter of the duct may be made by augering and the duct inserted.

(C) A drilled opening not more than 1" larger than the outside diameter of the duct may be made with a pneumatic vibrating machine and the duct inserted.

(D) HDPE conduit may be installed in accordance with Subarticle 1715-3(D).

Do not install non-metallic conduit by jacking method (A) as listed above.

If installation of a duct is begun and not completed, plug any opening as directed. Installation of duct by water jetting will not be acceptable.

At locations where it is indicated on the plans that the duct is to be connected to boxes, foundations, or other raceways, install in accordance with Subarticle 1400-4(E) Conduit Installation to provide an approved raceway as specified by the NEC.

1409-4 MEASUREMENT AND PAYMENT

Electrical duct (size and type) will be measured and paid as the actual number of linear feet of duct, measured in place to the nearest whole foot, that has been installed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Electrical Duct, (Size & Type) _____	Linear Foot

SECTION 1410
FEEDER CIRCUITS

1410-1 DESCRIPTION

Furnish and install all conductors and conduit, including tools, equipment, trenching, and backfilling to provide electrical circuits at locations shown on the plans.

1410-2 MATERIALS

Use load current carrying conductors which are UL Type USE, except that UL Type UF may be used for sizes 8 AWG and smaller. The equipment grounding conductor may be bare or insulated. Use conductors which are copper and in accordance with Subarticle 1400-2(C). For feeder circuits size 10 AWG, a cable assembly UL Type UF with the proper number of conductors may be used in lieu of individual conductors. Give careful attention to the required color code. Do not mark a white conductor in a cable assembly any other color; however, it may be stripped at all accessible points and used as a bare equipment grounding conductor.

Provide metallic (rigid galvanized steel) and non-metallic (polyvinyl chloride or high density polyethylene) conduit in accordance with the Subarticle 1400-2(B) Conduit with the appropriate type being used at locations as shown on the plans.

1410-3 CONSTRUCTION METHODS

Install feeder circuits in continuous runs, without splices, except at junction boxes or within light standard bases.

Install conductors in accordance with the Subarticle 1400-4(F) and conduit in accordance with the Subarticle 1400-4(E).

Excavate trenches to depths and widths as shown on the plans with essentially vertical walls and as straight as possible, when underground feeder circuits are required. Locate underground feeder circuits a minimum of 6 feet back of the face of curb or outside the limits of the paved shoulder and stone base, as directed. Use care to prevent conflict with existing or future guardrails, sign posts, delineators, and similar devices.

Surround the underground feeder circuit in conduit with clean soil and use backfill free of rocks and other objectionable materials which might damage the conduit. This will require partial backfilling by hand in areas where it is likely that objectionable materials will be included if mechanical methods of backfilling are used.

Perform all necessary search methods, including but not limited to use of underground metal detection equipment and excavation equipment, to locate existing electrical duct. Locate the duct and perform all necessary work including cleaning of the duct before installation of proposed circuits.

When a feeder circuit in conduit passes through electrical duct, make the conduit continuous through the duct unless specifically noted otherwise on the plans. After feeder circuits in conduit are extended through duct, plug the duct with oakum or duct seal.

When only feeder circuits are required, install the load current carrying conductors and grounding conductors in either existing conduit or conduit installed under other contract items.

When more than one circuit is installed in a single raceway, a single equipment grounding conductor sized as required for the largest circuit may be used without change in the contract unit bid prices.

Multiple circuits may be placed in the same trench if they are grouped and separated a minimum distance of 3". When more than one circuit is installed in the same trench there will not be any adjustment of the contract unit bid prices.

1410-4 MEASUREMENT AND PAYMENT

___ *Feeder circuits* will be measured and paid for as the actual number of linear feet of each size and type feeder circuit that has been completed and accepted. Measurement will be to the nearest whole foot from electrical terminal to electrical terminal of the longest load current carrying conductor.

Feeder circuit in ____*conduit* will be measured and paid for as the actual number of linear feet of each size and type feeder circuit that has been completed and accepted. Measurement will be to the nearest whole foot from electrical terminal to electrical terminal of the longest load current carrying conductor.

Payment will be made under the following pay items:

Pay Item	**Pay Unit**
_____ Feeder Circuit	Linear Foot
_____ Feeder Circuit in _____Conduit	Linear Foot

SECTION 1411
ELECTRICAL JUNCTION BOXES

1411-1 DESCRIPTION

Provide junction boxes made from fiberglass reinforced polymer concrete and cast-metal boxes encased in concrete of the appropriate type at locations noted on the plans, complete with all necessary covers, conduits, duct, and hardware, in accordance with the contract.

1411-2 MATERIALS

Use polymer concrete (PC) boxes which are stackable, and have bolted covers and are sized as shown in the plans.

Use polymer concrete material made of an aggregate consisting of sand and gravel bound together with a polymer and reinforced with continuous woven glass strands. Use material with the following minimum mechanical strength properties: 11,000 psi compressive, 1700 psi tensile, 7500 psi flexural.

Have the material meet minimum acceptance criteria for: chemical resistance, accelerated service exposure, simulated sunlight exposure, water absorption, flexural

properties, and flammability in accordance with ASTM D-543, D-756, D-1501, D-560, D-790, and D-635 respectively.

Provide light vehicular traffic design and base it on a 5000 pound load over a 10" x 10" area.

Provide a bottom box which is open footed unless specifically noted as closed bottom on the plans.

Provide a standard Electric logo on the cover unless specifically noted otherwise on the plans. Provide a minimum of 2 size 3/8" hex head stainless steel cover bolts and inserts.

Backfill beneath and around the boxes using ABC in conformance with Section 1005.

Use ground rods that are 5/8" in diameter, 8' long solid steel core with copper jacket. Provide a ground rod clamp made of one-piece bronze with a hex head screw. Both the rod and clamp shall conform *to UL Standard 467 Electrical Grounding and Bonding Equipment*.

Provide cast-metal (BR) box, replaceable frame, and cover that are hot dipped galvanized with factory or field drilled conduit entrances. Provide a cover with checkered imprint, pry bar slots, and reinforcing ribs for heavy loading, neoprene gasket, and brass or stainless steel bolts. Provide a blind tapped (1/4" NC thread minimum) boss on interior of box for grounding.

1411-3 CONSTRUCTION METHODS

Install conduits and duct before the polymer concrete (PC) boxes are set in place. Do not rest the bottom of the box directly on conduits, ducts or cables.

Place the top of the box on the same grade as the surrounding area except raise it 3" minimum to allow the backfill material to be sloped to prevent surface drainage from entering the box. Perform backfilling with sufficient care that no part of the junction box, conduit or duct is displaced or moved out of alignment. Place backfill material in 6" layers and compact to a density comparable to the adjacent undisturbed material.

Locate junction boxes for best routing of conduit and duct, and to minimize drainage problems. Do not locate boxes in useable shoulders or pavements or other areas where they may be subjected to traffic loadings.

Install a ground rod as indicated on the plans with bonding jumpers, etc. as required. Stub the ends of conduit and duct up vertical as near the top of the box as practical and seal. Arrange wiring so that it will not lay in the bottom of the box.

Place sealant between the cover and box to prevent surface drainage from entering the top of the box.

Install cast-metal (BR) boxes and arrange conduits and ducts to best fit field conditions. Place boxes, conduit, and ducts as the work is built up, thoroughly bonded and accurately spaced and aligned. Place boxes with covers flush with surface of concrete (generally traffic side of median barrier).

Place mastic between the cast metal box frame and the cast concrete barrier, as shown on plans to allow easy replacement of the frame.

1411-4 MEASUREMENT AND PAYMENT

Electrical junction boxes ___ will be measured and paid for as the actual number of the appropriate type and size junction boxes that have been installed and accepted. Payment for the conduit, duct and wiring will be paid for under other contract items. Ground rods, clamps and bonding jumpers are incidental to the junction boxes.

Payment will be made under:

Pay Item	Pay Unit
Electrical Junction Boxes_____	Each

SECTION 1412
UNDERPASS LIGHTING

1412-1 DESCRIPTION

Furnish and install wall mounted and/or pendant mounted luminaires with electrical circuitry, for underpass lighting at locations shown on the plans. Work includes but is not limited to furnishing and installing underpass luminaires with lamp, ballast, and mounting hardware as well as furnishing and installing circuit breakers and enclosure, pull boxes, conduit, conductors, expansion fittings, anchors, straps, and ground rod.

1412-2 MATERIALS

Use luminaires that are listed as Suitable for Wet Locations according to UL Standard #1572, with sealed and filtered optical assemblies. Use high power factor ballasts that are completely pre-wired integral units, for reliable starting and operating of high pressure sodium lamps at -40°F ambient temperature. Use heavy-duty mogul base lamp sockets, with split shell tempered brass lamp grips and a free-floating, spring-loaded center contact. Use the luminaire type, wattage, voltage and IES illumination distribution pattern as shown on the plans.

Provide type WM luminaires that are wall mounted, with cast aluminum housing painted with premium quality gray or dark bronze paint. Provide a prewired ballast and terminal board assembly, and cast aluminum side-hinged door with glass refractor. Use the same color WM luminaires throughout the project. Provide factory installed mounting holes in the back, and conduit entrances in the sides and top. Provide a formed aluminum reflector and socket assembly, with a chemically bonded lightweight non-breakable glass finish, which is removable with only a screwdriver.

Provide type PM luminaires that are a pendant mounted assembly of ballast, optical and mounting components, including a safety chain and hanging hardware. Provide a die-cast aluminum ballast housing with gray paint finish, with a prewired ballast assembly and an external quick electrical disconnect receptacle for attachment of hanging hardware. Provide a faceted aluminum reflector with an Alzak (proprietary term of Aluminum Company of America) finish, and a lightly diffused refractor made of UV stabilized, injection molded, prismatic, heat-resistant, acrylic. Provide hinges and stainless steel, over-center, vibration-

resistant spring latches for easy access to the lamp, and clamping of the gasket between the refractor and ballast housing.

Use a 3/4" rigid galvanized steel conduit with a hook and power cord entrance as the pendant. Provide a 3-conductor type SO power cord and a 3/4" female threaded wiring compartment with quick electrical disconnects, to attach the ballast housing to the pendant as shown in the plans.

Use galvanized weldless forged steel eye-nuts that comply with Federal Specification WW-H-171E (Type 17), or Manufacturers Standardization Society SP-69 (Type 17). Attach eye-nuts to galvanized steel or stainless steel threaded rod that has been anchored to the bridge deck with adhesive anchors. Use galvanized steel or stainless steel safety chain, S hooks and lock nuts.

Use conduit and wire in accordance with Article1400-2, and gasketed PVC junction boxes as shown in the plans.

Use a 2-pole, 480 VAC, 20 AMP circuit breaker, installed in a NEMA 3R enclosure that has been primed and painted with a premium grade exterior paint before installation, to increase corrosion resistance. Install an equipment ground bar, and provide a lock in accordance with Article 1400-8 .

1412-3 CONSTRUCTION METHODS

Mount luminaires as shown in the plans. Use galvanized steel or stainless steel clamps and attachment hardware.

Install circuitry in accordance with the requirements of Article 1400-4, titled Wiring Methods and Conduit Installation.

1412-4 MEASUREMENT AND PAYMENT

Underpass luminaires ____ will be measured and paid for as the actual number that have been installed and accepted.

Underpass circuitry will be paid for at the contract lump sum price for Underpass Circuitry at _____ at the appropriate location.

Payment will be made under:

Pay Item	**Pay Unit**
Underpass Luminaires _____	Each
Underpass Circuitry at _____	Lump Sum

SECTION 1413
PORTABLE CONSTRUCTION LIGHTING

1413-1 DESCRIPTION

Furnish, operate and maintain everything necessary to provide lighting for compliance with Article 105-14 Night Work requirement for artificial lighting.

1413-2 MATERIALS

Furnish all lighting equipment as required and retain after the work is completed. Material and/or equipment is not required to be new but shall be in good operating condition and in compliance with applicable safety and design codes.

Submit, for the review and approval catalog cuts giving the specific brand names, model numbers and ratings of the lighting equipment. Include in the submittals power ratings and photometric data. Allow 40 days for review of the submittals. Do not begin night work without approval of the equipment and/or materials.

1413-3 TOWER LIGHT

Use tower lights which consist of mercury vapor, metal halide, high pressure sodium or low pressure sodium fixtures mounted on a tower approximately 30' in height. Use tower light fixtures which are heavy duty flood, area, or roadway style with wide beam spread, have an output of 50,000 lumens minimum, have the combined outputs of all fixtures on each tower light not exceed 460,000 lumens, and are weatherproof and supplied with attached waterproof power cord and plug. Use a sturdy tower which is freestanding without the aid of guy wires or bracing. Provide sufficient capacity in the power supply to operate the light(s) and locate it for the shortest safe routing of cables to the fixtures. A tower light consisting of the combined fixture(s), tower and power supply is preferred.

Provide tower lights of sufficient wattage and/or quantity to provide an average maintained horizontal illuminance greater than 20 footcandles over the work area.

Aim and position the lights to illuminate the area for construction work. Make sure that there is not any disabling glare to the motorist. In no case should the main beam of the light be aimed higher than 60° above straight down. The lights should be set as far from traffic as practical and aimed in the direction of, or normal to, the traffic flow.

1413-4 MACHINE LIGHTS

Use machine lights which have mercury vapor, metal halide, high pressure sodium or low pressure sodium conventional roadway enclosed fixtures mounted on supports attached to the construction machine at a height of approximately 13'. Use fixtures for machine lights which have light output between 22,000 and 50,000 lumens. Use a power supply with sufficient capacity to operate the light(s) and securely mount on the machine. Perform electrical grounding of generators to frames of machines on which they are mounted in conformance with the National Electrical Code (NEC).

Use machine light fixtures with sufficient wattage and/or quantity to provide an average maintained horizontal illuminance greater than 10 footcandles on the machine and the surrounding work area. Machine lights are in addition to conventional automotive type headlights which are necessary for maneuverability.

1413-5 CONSTRUCTION METHODS

Use tower lights when the night work is confined to a fairly small area and is essentially a stationary operation. Space tower lights no closer than 100 feet apart and no further than 300 feet apart. Actual spacing will be determined by approved equipment. At any spacing, the required 20 footcandles of light will be the determining factor.

Use machine lights when the night work is not confined to a small area and is essentially a continuous moving construction operation.

Tower lights may be provided in lieu of machine lights upon approval by the Engineer. Use of tower lights in lieu of machine lights will be considered when the number of machines, type of work, or need for inspection justify their use as decided by the Engineer.

Illuminate the work area where traffic control devices are being set up or repositioned at night.

The work areas to be illuminated are the areas where construction equipment and labor are in operation and may be different from the work areas shown in the plans.

Illuminate a large enough work area so that the movements of all personnel and equipment engaged in the work will be contained in the area.

Provide sufficient fuel, spare lamps, generators, and personnel qualified to operate the lights to assure that they will be maintained in operation during night work.

Existing streetlights do not eliminate the requirement for the Contractor to provide lighting. Consideration may be given to the amount of illumination provided by existing lights in determining the wattage and/or quantity of lights to be provided.

1413-6 MEASUREMENT AND PAYMENT

Portable lighting provided by tower and machine lights will be made only when a significant amount of nighttime work is explicitly required and a pay item for portable lighting has been included in the contract. Otherwise, portable construction lighting will be considered incidental to other contract items and no direct payment will be made.

The aggregate amount to be paid on each partial payment estimate will be equal to the percentage that the item of Portable Lighting is complete as estimated by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Portable Lighting	Lump Sum

DIVISION 15
UTILITY CONSTRUCTION

SECTION 1500
GENERAL UTILITY REQUIREMENTS

1500-1 DESCRIPTION

Construct various utilities as required by the contract or as directed.

Apply the applicable provisions of the Rules and Regulations of the North Carolina Department of Environment and Natural Resources, Division of Environmental Health to the construction of water lines. Apply the Rules and Regulations of the North Carolina Department of Environment and Natural Resources, Division of Water Quality to the construction of sanitary sewer lines. Perform all work in accordance with the applicable plumbing codes.

1500-2 COOPERATION WITH THE UTILITY OWNER

The Utility owner owns the existing utility facilities and will own the new utility facilities after acceptance by the Department. The Department owns the construction contract and has administrative authority. Communications and decisions between the Contractor and Utility Owner are not binding upon the Department or this contract unless authorized by the Engineer. Agreements between the Utility Owner and Contractor for work that is not part of this contract or is secondary to this contract are allowed, but are not binding upon the Department.

Provide access for Department personnel and the owner's representatives to all phases of construction. Notify Department personnel and the utility owner two weeks prior to commencement of any work and one week prior to service interruption. Keep utility owners' representatives informed of work progress and provide opportunity for inspection of construction and testing.

Except in an emergency, do not operate any of the controls on the existing systems without prior approval of the owner.

Notify the owner at least 24 hours in advance of all arrangements for temporary service and for agreement with the owner as to the time that service may be interrupted.

1500-3 UTILITY LOCATIONS AND CONTRACTOR'S RESPONSIBILITY

The plans depict the best available information for the location, size, and type of material for all existing utilities. Make investigations for determining the exact location, size, and type material of the existing facilities as necessary for the construction of the proposed utilities and for avoiding damage to existing facilities. Repair any damage incurred to existing facilities to the original or better condition at no additional cost to the Department.

Make final connections of the new work to the existing system where indicated on the plans, as required to fit the actual conditions, or as directed.

WEEKEND, NIGHT AND HOLIDAY WORK

Make connections between existing and proposed utilities at times most convenient to the public, without endangering the utility service, and in accordance with the utility owner's requirements. Make connections on weekends, at night, and on holidays if necessary.

1500-5 RELATION OF WATER MAINS TO SEWERS

Lay water mains at least 10 feet laterally from existing or proposed sewers. If local conditions or barriers prevent a 10 foot separation, lay the water main with at least 18 inches vertical separation above the top of the sewer pipe either in a separate trench or in the same trench on a bench of undisturbed earth.

When a proposed water main crosses over a proposed or existing sewer, lay the water main with at least 18 inches vertical separation above the top of the sewer. If local conditions or barriers prevent an 18 inch vertical separation, construct both the water main and the sewer for a distance of 10 feet on each side of the point crossing with ferrous pipe having water main quality joints.

When a proposed water main crosses under a proposed or existing sewer, construct both the water main and the sewer of ferrous materials with joints that are equivalent to water main standards for a distance of 10 feet on each side of the point of crossing. Center the section of water pipe at the point of crossing.

1500-6 PROTECTION OF PEDESTRIAN AND VEHICULAR TRAFFIC

During the progress of the work, keep sidewalks and crossings open for the passage of pedestrians. Take necessary measures to keep roadways open for traffic unless lane or roadway closures are approved.

Construct and maintain adequate and approved bridges over excavations as may be necessary for the purpose of accommodating pedestrians or vehicles.

When open cut installation is allowed across a roadway and traffic is to be maintained, construct the installation in sections so that half the width of the roadway will be available to traffic. Provide all traffic control measures necessary to provide for safe traffic passage.

1500-7 SUBMITTALS AND RECORDS

Deliver only approved materials to the project. Provide sufficient information as required under Sections 105 and 106 to demonstrate the materials meet the specifications and intended use. Provide 2 copies to the Utility Owner and 6 copies to the Engineer. Identify each item's intended use. As a minimum, the submitted information shall show the material description, brand name, stock number, size, rating, and manufacturing specification.

Provide working drawings of thrust restraint designs and connection details along with schedules for performing the work.

Provide As-Built plans of the installed utility. The plans shall include notations of the size and type material installed, coordinates of utility controls, and horizontal and vertical locations of the piping. Provide 2 copies to the Utility Owner and 2 copies to the Engineer.

1500-8 LOCATING AND MARKING

Tape a continuous locator wire along the top of all piping. Mechanically fasten locator wire to valve boxes, meter boxes, fire hydrants, manhole covers and other above grade appurtenances. Install marking tape 18 to 24 inches below finished grade above all pipelines.

1500-9 PLACING PIPELINES INTO SERVICE

Make final connections to existing mains where indicated on the plans, as required to fit the actual conditions, or as directed. Provide sufficient work crews, equipment, and materials on site to assure quick and efficient connections.

Schedule and notify owners and customers in advance of any interruptions of water service with ample time to make arrangements. Limit interruption of service to water customers to a maximum of 8 hours unless otherwise required or approved. Provide temporary connections as needed.

Make final connections of the proposed sewer work to the existing system where indicated on the plans, as required to fit the actual conditions, or as directed. Notify the owner at least 24 hours in advance of all arrangements for temporary service and for agreement with the owner as to the time that service may be interrupted.

1500-10 MEASUREMENT AND PAYMENT

The general utility construction work will be considered incidental and will be paid for at the contract unit prices of the various utility items included in the contract.

SECTION 1505
EXCAVATION, TRENCHING, PIPE LAYING, & BACKFILLING FOR UTILITIES

1505-1 DESCRIPTION.

Perform all excavation, undercut, foundation conditioning, pipe laying, bedding, backfill, and pavement, sidewalk and driveway repair necessary for installation of utilities.

1505-2 MATERIALS

Refer to Division 10:

Item	Section
Select Material	1016
Portland Cement Concrete	1000

Use Class III, IV, V, or VI select material for foundation conditioning and bedding.

1505-3 CONSTRUCTION REQUIREMENTS

Excavate, trench, lay pipe, bed, and backfill utilities in conformance with the applicable requirements of Division 1, Division 2, and Articles 300-1, 300-4, and 300-6. Comply with AWWA and ASTM standards along with the product manufacturer requirements for installing utilities.

(A) Shoring

Excavate trenches and pits for the installation of utilities that are safe for the workers and roadway users and that protect the roadway and other property from damage. Provide appropriate groundwater and surface water controls to stabilize the excavation and foundation and to provide a clean working area.

(1) Worker Safety

Provide any necessary shielding or shoring to protect workers.

(2) Roadway Users

Provide shielding or shoring as required under Sections 150 and 1175.

(3) Roadbed and Foundation Protection

Provide shoring of excavations less than 1 horizontal to 1 vertical from existing or proposed pavement to prevent failure or weakening of the roadbed. Provide plans and designs demonstrating the methods and techniques proposed and their adequacy. Provide engineered shoring systems as required for the actual conditions.

(B) Foundation Conditioning

Undercut and replace weak or saturated soils below the pipe trench with select material to provide a firm foundation.

(C) Bedding

Provide excavations with sufficient width for placing and compacting bedding around the utility. Bed utilities in select material. Place bedding material to stable ground on both sides and to at least 2 inches below and above the pipe bells. Provide at least 6 inches of bedding material between rock and piping. Shape the bottom of trenches to fit the pipe. Compact bedding material completely in the pipe haunches. Provide recesses in the bedding to accommodate pipe joints.

(D) Pipe laying

Lay pipe in accordance with the specifications and the manufacturer's recommendations. Except where necessary in making connections with other lines or as authorized by the Engineer, lay pipe with the bells facing in the direction of laying.

Where possible, keep joints exposed for visual inspection during testing.

Keep pipe and appurtenances clean. Provide secure watertight seals on pipe when work is not in progress.

During the progress of the work and until the completion and final acceptance, keep the pipelines and their appurtenances clean throughout and remove any obstructions or deposits.

Lay pipe upgrade with the spigot ends pointing in the direction of flow. Lay each pipe to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the flow line.

(E) Thrust Restraint

Provide thrust restraint for pressurized pipelines and appurtenances. When shown on the plans, construct as specified with modifications to match the actual field conditions. When not shown, engineer the thrust restraint system with a factor of safety of 1.25 for the test pressure specified and for the actual field conditions.

Provide thrust restraint on the existing piping system as necessary.

Use joint restraint methods, such as integral restraining bells and spigots, restraining retainer glands, restraining gaskets, or restraining clamps and lugs with tie rods. Use concrete reaction backing and thrust collars where joint restraint is impractical.

Where any section of a main is provided with concrete thrust restraint for fittings, controls, or hydrants, perform the hydrostatic pressure test after the concrete reaches appropriate strength.

(F) Backfilling

Backfill in accordance with Article 300-7 and compact to the density required by Subarticle 235-4(C).

1505-4 REPAIR OF PAVEMENTS, SIDEWALKS AND DRIVEWAYS

Repair sidewalks and driveways that are disturbed by excavation and trenching to an original or better condition using Class B Concrete.

Use asphalt plant mix to repair or replace pavement damaged by utility work. Perform all work in accordance with Section 654. Immediately upon completion of the utility removal or installation, make repairs to the pavement.

1505-5 CONCRETE ENCASEMENT OF UTILITY LINES

Encase existing or proposed utility lines in Class B concrete for protection in areas as shown on the utility plans or as directed. Place the concrete completely around the line with a minimum thickness of 6 inches.

MEASUREMENT AND PAYMENT.

Trenching, excavation, pipe laying, bedding, and backfilling for utility construction will be considered as included in the contract price for the applicable utility item and no separate measurement or payment will be made.

The following work and items will also be considered as included in the contract price for the applicable utility item and no separate measurement or payment will be made:

(1) Undercut or Wet Excavation
(2) Dewatering of Excavation
(3) Shoring and Sheeting (except temporary shoring for maintenance of traffic covered in Section 1175)
(4) Thrust restraint
(5) Repair of Sidewalks and Driveways

Foundation Conditioning
Foundation conditioning material will be measured and paid for as provided in Section 300.

Bedding Material
Bedding material will be considered incidental and no separate measurement or payment will be made.

Select Material for Backfill
Select material for backfill will be measured and paid for as provided in Section 300.

Asphalt Plant Mix
Asphalt Plant Mix for pavement repair will be measured and paid for as provided in Section 654.

Concrete for Encasing Utility Lines
Class B concrete for encasing utility lines will be measured and paid for in cubic yards of concrete, measured in place.

Payment will be made under:

Pay Item	**Pay Unit**
Class "B" Concrete for Encasing Utility Lines	Cubic Yard

SECTION 1510
WATER LINES

1510-1 DESCRIPTION

Provide water lines suitable for use in transporting potable water.

1510-2 MATERIALS

Refer to Division 10:

Item	Section
Portland Cement Concrete	1000
Water Pipe and Fittings	1036

The Contractor may use any of the water pipe specified under Section 1036 except where a particular type pipe is specified on the plans or required by environmental regulations or Departmental policy. The Contractor shall verify that the pipe is appropriate for the test pressure of the system and the external loading.

Use ductile iron fittings on water lines 4 inch or larger.

Use #12 AWG solid-copper wire with blue insulation for the utility locator wires.

Use 2 inch wide plastic marking tape colored blue with "Caution Water Line", or similar wording, permanently printed at 36 inch centers.

Use Class B Concrete for reaction backing masonry. Protect steel rods and other metal clamps and lugs by galvanizing or painting with approved bituminous paint.

1510-3 CONSTRUCTION REQUIREMENTS

Meet the installation standards of the AWWA or ASTM for water line construction.

Apply all the requirements in Section 1505 for excavation, trenching, pipe laying, and backfill to water line installation.

Install small diameter pipe (4" or less) under existing pavement by a trenchless method at no additional compensation.

Connect the ends of the water service piping using AWWA C800 type couplings or fittings. Make NPT screw joints with a double wrap of Teflon tape and torque as required by the manufacturer.

Store plastic pipe out of direct sunlight until placing. All plastic pipe showing discoloration or deterioration will be rejected for use and replaced with suitable pipe as specified under Article 106-9.

Install water lines with 36 to 42 inches of cover to finished grade unless otherwise directed or approved. Install water lines with greater cover for short distances to accommodate utility controls, to make tie-ins to existing facilities, to eliminate high points in the pipeline, or to provide clearance from existing or proposed utilities, drainage, other obstacles or actual field conditions.

(A) Testing and Sterilization

Perform pressure and leakage tests and sterilization on newly installed water mains and altered water mains prior to placing such pipelines into service. Provide all equipment, piping, controls, pumps, water, and safety devices necessary for performing the tests and sterilization.

Obtain clean water for cleaning, testing, and sterilization from approved sources. Only make connections to potable water sources with approved backflow preventors until acceptance of all test results.

Perform tests using clean water and provide certified results demonstrating leakage less than the following amount when pressurized at 200 ± 5 psi for 2 hours.

$$W=LD(\sqrt{P})\div(133,200)$$

Where **W** equals the allowable leakage in gallons per hour; **L** is the length of pipeline tested, in feet; **D** is the nominal diameter of the pipe, in inches; and **P** is the average test pressure during the leakage test, in pounds per square inch.

Repair using approved methods or replace pipe, controls, or appurtenances as necessary to reduce leakage. Additionally, repair any leaks that are visible after 2 hours duration.

Clean water lines by flushing with water at a minimum 2.5 feet per second velocity. Remove all debris and dirt from water mains larger than 4 inches by passing a medium density foam pig with abrasive strips through the lines.

Sterilize water lines according to DENR requirements and AWWA C651. Provide certified bacteriological and contaminant test results from an approved independent testing laboratory in accordance with DENR requirements. Operate all valves and controls to assure thorough sterilization.

Testing, cleaning and sterilization may be performed concurrently or consecutively.

Dispose of waste water in accordance with all environmental regulations.

For short sections (less than 100 feet) and tie-in sections of water lines perform visual tests for leakage after installation in lieu of separate pressure and leakage tests. Sterilize according to AWWA C651 Sections 4.6 and 4.7.

Provide copies of the test results to the Engineer and to the water line owner.

Flush with clean water until the residual chlorine is reduced to the same level as in the existing water mains.

Place new water lines into service after approval of all testing and flushing and authorization by the Engineer.

MEASUREMENT AND PAYMENT

Water lines of the various sizes will be measured from end to end in place with no deduction for length through valves or other fixtures and paid for by the horizontal linear foot. Water lines smaller than 2 inches and branch lines or service lines to fire hydrants, water meters, and back-flow preventors will not be measured or paid for.

If the contract does not include such pay items, measurement will not be done and the items will be incidental to other contract pay items.

Payment will be made under:

Pay Item	Pay Unit
__" Water Line	Linear Foot

SECTION 1515
UTILITY CONTROLS

1515-1 DESCRIPTION

Provide appropriate control devices, valves, meters, back-flow preventors, and hydrants on water lines and force main sewers.

1515-2 MATERIALS.

Refer to Division 10:

Item	Section
Sanitary Sewer	1034
Water	1036

Deliver only approved materials to the project.

Air release valves shall meet the requirements of AWWA C512. In addition, air release valves for sanitary sewer force mains shall have long bodies, shall be equipped with back-flushing connections and shall have a hood over the outlet.

Double check valves (DCV) Back-flow Preventors shall meet AWWA C510 requirements. Reduced Pressure Principle (RPZ) Back-flow Preventors shall meet AWWA C511 requirements.

Line stops consist of a sleeve, temporary valve and closure cap. The sleeve and cap shall meet applicable AWWA standards, shall be made of cast iron or stainless steel, shall be pressure rated at 200 psi, and shall be sized for the type pipe to be tapped. The temporary valve shall be suitable for contact with potable water with NSF certification and designed to match the actual field conditions.

Line stop bypass pipe shall be pressure rated at 200 psi, shall be NSF certified, and shall be adequately restrained.

Use screw or slip type valve boxes with a base to fit the valve yoke and a removable plug cap with the word "WATER" or “SEWER” cast therein.

Precast manholes shall meet the requirements of Section 1525.

1515-3 CONSTRUCTION REQUIREMENTS

1515-4 General Requirements

Apply all the requirements in Section 1505 for excavation, trenching, pipe laying, and backfill.

Place two 4 inch by 8 inch by 16 inch concrete blocks beneath valves and fire hydrants for support.

When necessary due to project staging, install valves, meters and fire hydrants as appropriate for the current grade and make adjustments to finished grade as work progresses.

Provide enclosures with positive drainage for utility controls.

(A) Valves

Install all valves with an approved valve box set flush with the ground or pavement. Place a 24 inch diameter precast concrete ring flush with the ground around all valve boxes not in pavement.

Test and sterilize tapping valves prior to making the tap. Do not allow cuttings to enter the tapped main.

(B) Meters

Install water meters adjacent to the right of way or as shown on the plans.

Place meter boxes with the top of the meter box flush with finished grade of the project.

(C) Back-Flow Preventors

Install back-flow preventors off of the highway right of way or as shown on the plans.

Licensed installers shall test and certify RPZ Back-Flow Preventor installations. Enclose RPZ Back-flow preventors above grade in a hot box.

Enclose DCV Back-flow Preventors below grade in a precast concrete vault with positive drainage or above grade in a hot box.

Install the hot box on a 4 inch thick concrete slab that is 6 inches larger than the box and 2 to 4 inches above finished grade.

Fire Hydrants

Install fire hydrants outside of the vehicle recovery area of the roadway, adjacent to the right of way line, or in protected areas.

Connect fire hydrants to the main with a 6 inch valve and branch line having at least as much cover as the distribution main. Set hydrants plumb with the pumper nozzle facing the roadway and with the breakaway safety flange between 1 and 4 inches above the finished surrounding grade. Except where approved otherwise, place

hydrants into service as soon as practicable. Place at least 7 cubic feet of clean crushed stone around the base of the hydrant to insure drainage of the hydrant barrel.

Where necessary, remove the hydrant shoe and replace with the appropriate type to connect a relocated hydrant to the new pipe. Furnish and install or remove hydrant extension pieces to provide the proper bury of the pipe and hydrant.

(E) Line Stops

Provide line stop valves to temporarily shut down the flow in pressurized pipes. Provide line stops to temporarily dead end a pipeline when there are no available working valves on the existing piping. Provide line stops with bypass to isolate a section of the existing pipeline while maintaining the flow.

After line stop valves are removed, permanently cap the tapping sleeve and backfill the entire excavation with compacted select material.

(F) Air Release Valves

Install air release valves at the high point of pressurized pipelines. Place a precast manhole around air release valves.

(G) Miscellaneous Controls

Install corporation stops with tapping saddles for connecting 2 inch or smaller water lines to larger water lines. Install corporation stops at 45°±10° from vertical on the larger line.

To aid in testing and flushing, install corporation stops at all elevated points along the pipeline in order to bleed off all entrapped air.

1515-5 MEASUREMENT AND PAYMENT

Valves, water meters, fire hydrants, line stops, and other items listed in the pay items will be measured and paid for per each for the appropriate size and type. Valves and other items on hydrant legs or service lines will not be measured or paid for.

The term *relocate* in a pay item means to physically move the existing item, either vertically or horizontally, using the appropriate materials to place the item into working order. Measurement and payment will be made per each for the appropriate size and type.

No additional compensation will be made for adjustments due to project staging on new or relocated items.

Reconnect water meter means to transfer or replace the piping from a new water line to an existing water meter that is not relocated. Measurement and payment will be made per each.

Valve boxes, meter boxes, hot boxes, vaults, and manholes for protecting and servicing utility controls are considered incidental to the appropriate pay item.

A line stop with bypass consists of installing line stops on opposite ends of the piping to be isolated, tapping the piping beyond the line stops, and providing temporary bypass piping

between the taps. The entire assembly of valves and piping will be measured as one unit and paid for per each.

Corporation stops or other items to aid in testing and flushing of the piping are incidental items.

If the contract does not include such pay items, measurement will not be done and the items will be incidental to other contract pay items. All piping, fittings, controls, certifications, appurtenances, and other miscellaneous items necessary to place the new or relocated item in proper working condition are considered incidental.

Payment will be made under:

Pay Item	Pay Unit
__" Valve	Each
__" Tapping Valve	Each
__" Air release Valve	Each
__" Blow Off	Each
__" Water Meter	Each
Relocate Water Meter	Each
Reconnect Water Meter	Each
__" DCV Back-Flow Preventor	Each
Relocate __" DCV Back-Flow Preventor	Each
__" RPZ Back-Flow Preventor	Each
Relocate __" RPZ Back-Flow Preventor	Each
Fire Hydrant	Each
Relocate Fire Hydrant	Each
__" Line Stop	Each
__" Line Stop with Bypass	Each

SECTION 1520
SANITARY SEWER

1520-1 DESCRIPTION

Provide sanitary sewers suitable for transporting sewage.

1520-2 MATERIALS

Refer to Division 10:

Item	Section
Sanitary Sewer Pipe and Fittings	1034

Use any of the pipe specified under Section 1034 except where a particular type pipe is specified on the plans or required by Environmental regulations or Departmental policy. Verify the pipe is appropriate for the test pressure of the system and the external loading.

Use ductile iron fittings on pressurized (force main) pipelines 4 inch or larger.

Use screw type plastic or brass clean-out covers.

Use #12 AWG solid-copper wire with green insulation for the utility locator wires.

Use 2 inch wide plastic marking tape colored green with "Caution Sewer Line," or similar wording, permanently printed at 36 inch centers.

1520-3 CONSTRUCTION REQUIREMENTS

Apply all the requirements in Section 1505 for excavation, trenching, pipe laying, and backfill to sanitary sewer installation.

Assemble pipe in accordance with the recommendations of the manufacturer.

Install PVC pipe in accordance with approved bedding methods.

Install vitrified clay sewer pipe in accordance with ASTM C12.

Install 4 inch minimum diameter sanitary sewer clean-outs flush with finished grade on 4 inch and 6 inch service lines. Provide clean-outs at the right of way line and at changes in direction. Do not locate clean-outs within the roadway pavement or shoulders. Provide clean-outs no more than 50 feet apart when beyond the roadway shoulders.

Use ductile iron pipe for sewers with 10% or greater slope.

Install sewer lines entering manholes with the crown at or higher than the sewer line leaving the manhole.

Install small diameter (4" or less) under existing pavement by a trenchless method at no additional compensation.

Gravity Sanitary Sewer

Construct gravity sanitary sewers in conformance with NCDENR *Gravity Sewer Minimum Design Criteria*.

(1) Pipe Installation

Use fittings or saddles to connect service lines to the sewer main.

Maintain sewer flow at all times. Use temporary diversions or pumping to maintain flow when connecting proposed sewers to existing sewers. Use

engineered temporary pumping systems capable of handling full pipe flow. Use pumping systems with automatic reliable operation or constantly tended manual operation.

(2) Testing

Perform tests on newly installed sewers and altered sewers prior to placing into service. Provide all equipment, piping, controls, pumps, water, and safety devices necessary for performing the tests.

Test all gravity sewer lines for leakage using one of the following methods:

(a) Infiltration

For sewer lines greater than 3 feet below groundwater, measure the amount of water infiltrating into the pipeline between manholes during a minimum of 24 hours. Repair leaks or replace piping when the rate of infiltration exceeds **W = 0.000789LD** in which **W** equals the maximum allowable leakage in gallons per hour; **L** is the length of pipe tested in feet; and **D** is the nominal diameter of the pipe, in inches.

(b) Exfiltration

For sewer lines above groundwater, perform an exfiltration test on the pipeline between manholes. Repair leaks or replace piping when the rate of exfiltration exceeds **W = 0.000789LD** in which **W** equals the maximum allowable leakage in gallons per hour; **L** is the length of pipe tested in feet; and **D** is the nominal diameter of the pipe, in inches.

The exfiltration test shall consist of securely plugging the pipe at the lower manhole and filling the pipeline with water. Allow the water to set for 24 hours in clay or concrete pipes. Raise the water level in the upstream manhole to 3 feet above the top of pipe. After 4 hours, measure the amount of water required to bring the water level back to the level at the start of the test and record the time.

Perform exfiltration tests through a series of manhole to manhole segments to limit the length of pipe tested to between 300 feet and 1500 feet. Shorter sections may be tested with longer test times. No additional leakage allowance for manholes permitted.

(c) Air Test

In lieu of hydrostatic testing, sewer lines 24 inch in diameter or smaller may be air tested in accordance with ASTM C-828, ASTM C924 and the following. Securely plug the sewer pipe at the manholes. Fill the pipe with air to 4.0 psi and hold this pressure for 5 minutes. Reduce the pressure to 3.5 psi. Measure the time for the pressure to drop 1.0 psi to the new pressure of 2.5 psi. Exceed the minimum test time given in the chart below for test times per 100 feet for the appropriate nominal pipe diameter.

Pipe Size (Inches)	Test Time (Minutes/100 Ft.)	Pipe Size (Inches)	Test Time (Minutes/100 Ft.)
8	1.2	18	2.4
10	1.5	21	3.0
12	1.8	24	3.6

(d) Visual Inspection

Visually inspect sewer lines larger than 24 inch from the inside using approved cameras. Correct any leakage, rolled gaskets, or defects.

(e) Line and Grade

Test all sewers for straight alignment by lamping or using a laser.

(f) Deflection Testing

Perform deflection tests on all flexible pipes. Conduct the test after the final backfill has been in place at least 30 days to permit stabilization of the soil-pipe system. As an alternative to waiting 30 days to permit stabilization of the soil-pipe system, provide certified soil testing verifying the backfill of the trench has been compacted to at least 95% maximum density.

No pipe shall exceed a deflection of 5 percent. If deflection exceeds 5 percent, relay the pipe.

The rigid ball or nine-point mandrel used for the deflection test shall have a diameter not less than 95 percent of the base inside diameter or average inside diameter of the pipe depending on which is specified in the ASTM Specification, to which the pipe is manufactured. The pipe shall be measured in compliance with ASTM D2122 Standard Test Method of Determining Dimensions of Thermoplastic Pipe and Fittings. The test shall be performed without mechanical pulling devices.

(B) Force Main Sanitary Sewer

Construct force main sewers in conformance with NCDENR "Minimum Design Criteria for the Fast-Track Permitting of Pump Stations and Force Mains."

(1) Installation

Install lines with 36 to 42 inches of cover to finished grade unless otherwise directed or approved. Install lines with greater cover for short distances to accommodate utility controls, to make tie-ins to existing facilities, to eliminate high points in the pipeline, or to provide clearance from existing or proposed utilities, drainage, other obstacles or actual field conditions.

Provide automatic air release valves at all high points.

(2) Testing

Perform pressure and leakage tests on newly installed force mains and altered sewers prior to placing such pipelines into service. Provide all equipment, piping, controls, pumps, water, and safety devices necessary for performing the tests and sterilization.

Test all new sewer force mains with clean water at 200 ±5 psi for a 2 hour duration. Vent all high points and expel all air. Provide certified results demonstrating leakage less than W=0.000106LD in which W equals the allowable leakage in gallons per hour; L is the length of pipe tested in feet; and D is the nominal diameter of the pipe, in inches.

Repair leaks using approved methods or replace pipe, controls, or appurtenances as necessary to reduce leakage. Additionally, repair any leaks that are visible after 2 hours duration.

1520-4 MEASUREMENT AND PAYMENT

Sanitary gravity sewer and *force main sewer* will be measured from end to end in place with no deduction for length through manholes, valves, or fittings and paid for per linear foot for the appropriate size. Where two different sizes enter or go from a manhole, each size will be measured to the center of the manhole. Unless otherwise shown on the plans, branch connections, ells, or other fixtures will be included in the length measurement.

Sanitary sewer clean-out will be measured and paid for per each. No measurement or payment of service lines will be made.

Payment will be made under:

Pay Item	Pay Unit
__" Sanitary Gravity Sewer	Linear Foot
__" Force Main Sewer	Linear Foot
Sanitary Sewer Clean-Out	Each

SECTION 1525
UTILITY MANHOLES

1525-1 DESCRIPTION

Provide utility manholes on water and sanitary sewer lines.

1525-2 MATERIALS.

Refer to Division 10:

Item	Section
Portland Cement Concrete	1000

Curing Agents	1026
Brick	1040-1
Concrete Block	1040-2
Mortar	1040-8
Precast Concrete Units	1077
Reinforcing Steel	1070
Structural Steel	1072
Steps	1074-8
Gray Iron Castings	1074-7(B)
Select Material	1016

Use precast concrete manholes with monolithic bottoms which conform to ASTM C478, AASHTO M199, and are as shown on the plans or in Roadway Standard Drawings. Use ASTM C-443 gaskets or AASHTO M198 flexible sealants for joints between precast manhole sections. Use resilient connectors for piping conforming to ASTM C923. Use ASTM A48 Class 35 cast iron or Grade 60 steel reinforcement steps with polypropylene plastic coating.

Use manhole frames and covers made of cast iron conforming to ASTM A48 Class 35, which are traffic bearing, have machined contact surfaces and are sized as shown. Use covers with 2 one-inch diameter air vents for vented manholes and use solid, non-vented covers with gaskets for watertight installation. Use covers with "Sanitary Sewer" or "Water" cast in large letters as appropriate for the type of utility.

Use Class B concrete unless otherwise indicated on the plans.

Use cement grout meeting the requirements of Article 1040-9 except use the mix portions of 1 part portland cement to 2 parts mortar sand.

1525-3 CONSTRUCTION REQUIREMENTS

Apply all the requirements in Section 1505 for excavation, trenching, pipe laying, and backfill.

Make connections of pipe to manholes in cored or precast holes using a resilient connector. Use horseshoe type holes only when approved. For horseshoe type holes wrap the pipe with a butyl rubber gasket and fill the space between the pipe and manhole with a non-shrinking grout.

Provide an outside drop assembly on manholes for sewer pipes entering with 2 ½ feet or more vertical drop. Inside drop assemblies may be used for connections to existing manholes when the drop exceeds 5 feet and the manhole diameter is greater than 4 feet.

In sewer manholes over 3 feet in depth, provide steps spaced 16 inches on center. Install steps in line with the effluent opening unless otherwise specified.

Construct invert channels to confine and direct the flow through sanitary sewer manholes. Use smooth finished invert channels that provide easy transition from inlet to outlet. Finish the benches or shelves to a non-slip texture and slope toward the invert channel. Precast invert channels are recommended but not required.

On deep manholes, a transition type manhole may be used provided there is a minimum of 6 feet from the manhole bench to the transition cone and the Engineer approves.

Construct manholes with the top of the cover

Location	**Top height above finished grade**
Roadway pavement	Flush ± ¼”
Driveways, sidewalks, Parking lots	Flush ± ½”
Vehicle Recovery Area	Flush ± 3”
Manicured Areas, such as lawns	Flush to +2” with concrete pad
Flood Zones less than 3 feet above finished grade	1 foot above 100 year flood elevation
Flood Zones greater than 3 feet above finished grade	2 feet above finished grade with watertight frame and cover and vent pipe to 1 foot above 100 year flood
Other areas	2 feet above finished grade

For manholes installed prior to finished grading or paving, construct the top flush with the current grade to provide access during all phases of construction and adjust as grading and paving work progresses in accordance with Section 858.

(A) Cast-In-Place Concrete, Brick, and Block Masonry

Construct concrete manholes in accordance with Section 825 with an ordinary surface finish. Construct brick masonry in accordance with Section 830. Furnish and place reinforcing steel in accordance with Section 425. Construct block masonry in accordance with Section 834 except that reinforcing will not be required.

Where necessary to fit field conditions, vary the dimensions of the manhole and footings as directed.

(B) Installation of Precast Units

Assemble precast manhole units in accordance with the manufacturer’s instructions and grout together to form a sound structural unit. Fill all lifting holes with non-shrink grout. Where it is necessary to use cast-in-place, brick masonry, or block masonry construction as part of the structure, apply the requirements of Subarticle 1525-4 (B) to such construction.

(C) Fittings and Connections

Where fittings enter the manhole, place them as the work is built up, thoroughly bonded, and accurately spaced and aligned.

Make pipe connections so that the pipe does not project beyond the inside wall of the manhole, and grout smooth and uniform surfaces on the inside of the manhole.

Set metal frames for covers in full mortar beds and mechanically secure by an approved method.

(D) Testing

Vacuum test all manholes prior to grouting and backfilling. Test according to ASTM C1244.

1525-4 MEASUREMENT AND PAYMENT

The height of the manhole will be measured and paid to the nearest tenth of a foot from the inside bottom (invert) of the manhole to the final finished top of the manhole ring.

Utility manholes will be measured and paid for by appropriate diameter per each for manholes of 0 to 6 feet height and per linear foot of height over 6 feet. No additional payment will be made for adjusting manholes to finished grade.

Drop assemblies will be incidental.

Payment will be made under:

Pay Item	Pay Unit
__' Dia Utility Manhole	Each
Utility Manhole Wall __' Dia	Linear Foot

SECTION 1530
ABANDON OR REMOVE UTILITIES

1530-1 DESCRIPTION

Abandon or remove utility facilities.

1530-2 MATERIALS

Refer to Division 10:

Item	Section
Portland Cement Concrete	1000
Select Materials	1016
Cement Grout	1040-9
Flowable Fill	340

Prepare cement grout to a consistency that will flow and be vibrated in order for the mix to flow uniformly into the pipe to be filled.

Use flowable fill in accordance with Section 340.

1530-3 CONSTRUCTION REQUIREMENTS

Apply all the requirements in Section 1505 for excavation, trenching, pipe laying, and backfill.

(A) Abandoning Pipe

Abandon utility pipes shown on the plans or designated by the Engineer by emptying the pipeline contents and plugging the ends with portland cement grout or flowable fill. Use the construction methods in Subarticle 340-3.

Fill or remove the following abandoned utility pipes:

(1) Pipe larger than 24 inches.

(2) Pipe located within the greater of the roadway typical section or the project slope stake line and one of the following:

  (a) Pipe 12 inches to 24 inches diameter located less than 20 feet below finished grade.

  (b) Pipe 6 inches to 12 inches diameter located less than 12 feet below finished grade and not made of cast iron, ductile iron or PVC.

  (c) Located below groundwater table that could become a conduit for water movement.

Excavate, remove, and dispose of properly any abandoned pipe to be removed. Backfill the resulting trench and properly compact using local excavated material or select backfill as required.

Fill abandoned pipe with grout or flowable fill to at least 90% full.

Remove any abandoned utility pipe exposed by grading operations to a minimum depth of 12 inches below subgrade elevation of the proposed roadbed or completed grading template.

Plug all abandoned utility pipes. Use grout to plug all abandoned utility pipes at the entrance to all manholes whether the manhole is to be abandoned or not. Use grout to plug all abandoned water mains after new mains are placed in service.

(B) Abandoning Manholes:

Abandon utility manholes in the construction limits by removing the top of the manhole to the manhole spring line or to an elevation of 2 feet below the roadway subgrade, whichever is greater, and filling the manhole barrel with approved material.

Plug connecting utility pipes before filling or removing the manhole.

Remove the manhole taper, wall, and base on all manholes to be removed.

Removed frames and covers become the property of the Contractor for proper disposal.

(C) Remove Water Meter:

Remove water meters by disconnecting and plugging the water service piping at the source main and plugging the piping at the right of way line. Return the meter to the utility owner. Dispose of all other parts, piping and boxes.

(D) Remove Fire Hydrant:

Remove fire hydrants by disconnecting and plugging the hydrant leg piping as close to the water main as possible. If the hydrant valve is within 4 feet of the main, close the valve, plug the outlet side of the valve and remove the valve box.

Removed hydrants become the property of the Contractor for proper disposal.

1530-4 MEASUREMENT AND PAYMENT

Utility pipe that is abandoned by filling or removal will be measured and paid for by the linear foot for the size of pipe. Utility pipe that is abandoned by plugging the ends only and leaving in place will not be measured or paid for. Cement grout used for plugging of abandoned utility pipe is incidental to the various utility items. Utility pipe that is removed by other work of the contract will be incidental to the other work.

Abandon Utility Manholes will be measured and paid for per each.

Remove Utility Manholes will be measured and paid for per each.

Remove Utility Water Meters and *Remove Fire Hydrants* will be measured and paid for per each.

Payment will be made under:

Pay Item	Pay Unit
Abandon __" Utility Pipe	Linear Foot
Abandon Utility Manhole	Each
Remove Utility Manhole	Each
Remove Water Meter	Each
Remove Fire Hydrant	Each

SECTION 1540
ENCASEMENT

1540-1 DESCRIPTION

Furnish and install encasement or casing pipes. For the purposes of this specification the words encasement, casing, encasement pipe and casing pipe are interchangeable.

1540-2 MATERIAL

Refer to Division 10:

Item	Section
Steel Encasement Pipe	1036-4 (B)
Treated Timber	1082-2
Concrete Pipe	1034-3
PVC Pipe	1034-2
Vitrified Clay Pipe	1034-1
Flowable Fill	340-2

Other pipe as designed by a licensed Professional Engineer.

Submit material certifications and obtain approval from the Engineer prior to installation.

CONSTRUCTION REQUIREMENTS

(A) Open Cut

Apply all the requirements in Section 1505 for excavation, trenching, pipe laying, and backfill.

(B) Jointing

Provide watertight joints on casing pipe less than 36 inches in diameter.

(C) Welding

Butt weld steel encasement pipe. Weld continuously around the circumference of the pipe to ensure that welds are watertight. Do not leave unwelded sections or holes in joints.

(D) Marker Posts

Mark encasements for future use with a treated wooden marker post. Place wooden marker post at the right of way or at the ends of encasements if encasements extend beyond the right of way.

(E) Carrier Pipe Installation

Install carrier pipe through casing using spacers or insulators to support the carrier pipe. Place spacers at intervals sufficient to support the carrier pipe without sagging. Install spacers sized to raise the carrier pipe bells above the encasement pipe invert.

Seal ends of casing with concrete, brick or other approved materials. Ensure drainage of encasement by leaving a 1 inch diameter weep hole in the seal of the lower end of the encasement.

(F) Casing Pipe Fill

Pump or place flowable fill into the annular void between the carrier pipe and casing pipes 36 inches or larger.

1540-4 MEASUREMENT AND PAYMENT

Encasement pipe will be measured from end to end and paid for at the contract unit price per linear foot for each size.

Payment will be made under:

Pay Item	Pay Unit
__" Encasement Pipe	Linear Foot

SECTION 1550
TRENCHLESS INSTALLATION OF UTILITIES

1550-1 DESCRIPTION

Install pipe using a trenchless method. Pipe refers to the specified pipe, which may be the primary carrier pipe or an encasement pipe. Shoring means the earth support system used for installing the pipe. The terms for encasement, casing, encasement pipe and casing pipe are interchangeable. Casing is considered shoring except where specified.

A Professional Engineer shall design the method and certify the work will not damage the roadway above or endanger the roadway user.

1550-2 MATERIAL

Refer to Division 10:

Item	Section
Encasement Pipe	1540
Treated Timber	1082-2
Grout	1040-9
Flowable Fill	340
Structural Timber	1082
Structural Steel	1072
Concrete	1000

Use pipe joints that are modified to suit the installation method. Provide engineering calculations for piping and shoring. Submit material certifications and obtain approval from the Department's Engineer prior to installation.

Use steel or concrete liner plates. Steel tunnel liner plates shall meet the requirements of AASHTO Section 16 and Section 25 *Standard Specifications for Highway Bridges*. Concrete liner plates shall meet AASHTO specifications.

Drilling fluids consist of water, bentonite and polymer additives.

Other materials will be considered with adequate design and quality control.

1550-3 CONSTRUCTION REQUIREMENTS

(A) General

Apply all the requirements in Section 1505 for excavation, trenching, pipe laying, and backfill.

Install the pipe to the lines and grades shown on the plans. Use workers that are skilled in the method of construction. Construct with good workmanship by skilled workers along with proper safety precautions.

Locate ends of trenchless construction and pits beyond the vehicle recovery area of the roadway. The vehicle recovery area may be reduced using acceptable traffic control methods.

(B) Design

Assess soil conditions expected during trenchless operations.

Use a trenchless method appropriate for the field conditions and for the specified pipe. Design the method to insure no settlement of the pipe or the completed roadway section. Use methods of construction and installation that will not disturb the soils outside of the immediate vicinity of the pipeline or pits.

Before construction, provide detailed plans for the method of installation certified by a Professional Engineer. Provide certified calculations demonstrating the method of installation as safe and of minimal risk. Provide certified calculations of the structural adequacy of all materials. The design shall meet the applicable requirements of *AASHTO Standard Specifications for Highway Bridges*. A Professional Engineer shall certify changes or modifications to the designed method as needed for actual field conditions.

(C) Water control

Provide groundwater control and removal as appropriate for the method of excavation and installation. Remove the groundwater using an engineered dewatering system. Keep surface waters out of the excavation and pits.

(D) Shoring

Maintain continuous and active support (shoring) to the soils surrounding both the pit and the trenchless excavation. Provide temporary or permanent shoring, as needed. Provide temporary shoring to maintain the hole or pit excavation for the duration of the work. Casing pipe 36 inches and larger, tunnel liner, pit and trench shoring, and shoring that is not certified for permanent use is considered temporary. Provide permanent shoring when desired or specified to maintain the open hole for an indefinite time. Permanent shoring requires certification of durability and a design life of 100+ years.

Fill all voids around the excavation and shoring with structural fill material as work progresses. Fill the annular space between the specified pipe and temporary shoring.

Either work continuously (24 hours/day and 7 days/week) on the operations from the time the excavation begins through the filling of voids or use an engineered system for shoring the excavation during work stoppage.

(E) Pre-Construction Meeting

The Contractor shall conduct a pre-construction meeting with the Department's Engineer to review the proposed method for installation of the pipe. Conduct the meeting at least 48 hours before beginning installation. The meeting shall consist of, but is not limited to:

(1) Presentation of the construction methods for understanding by all involved.

(2) Presentation of methods for filling any potential voids around the pipe.

(3) Advising the Department's Engineer of any work to be observed for *"Not In Soil"* classification.

(4) Demonstrating that appropriate equipment and materials are on site.

(5) Providing a progress schedule.

(6) Demonstrating ability to react to failures or roadway settlement.

1550-4 TRENCHLESS METHODS

(A) Bore and Jack

For bore holes up to 6 inches diameter in stable ground, the hole may be augured and the pipe pushed or jacked through the cleaned out hole. For bore holes greater than 6 inches, provide continuous support of the hole by simultaneously jacking the pipe or casing into the hole.

Use equipment suitably sized and designed to simultaneously bore or drill the soil or rock while pushing or jacking piping on a controlled grade. Position the cutter head within one diameter of the leading edge of the piping. In cohesive, dense, and dry soils and rock, position the cutter head in front of the leading edge. In non-cohesive or loose soils, position the cutter head inside the piping.

Dry bore only, do not use jetting or wet boring methods. Use drilling fluids only on the outside of piping for lubrication or hole stabilization.

Minimize over bore, match cutter diameter to the outside diameter of the encasement pipe. Limit overbore to 5% of bore diameter or 2 inches, whichever is less.

Provide steering controls as necessary to maintain line and grade.

(B) Directional Drilling

For drilled holes up to 6 inches diameter in stable ground, the hole may be drilled and reamed followed by pulling the pipe into the hole within 8 hours. For drilled holes greater than 6 inches, simultaneously pull the pipe or casing into the hole as reaming

occurs. Multi-pass reaming larger than 6 inches requires certification by the Contractor's Engineer that the soils are self-supporting of the dead and live loads.

When under pavement or within a 1 horizontal to 1 vertical distance from pavement, maintain the following depth of cover:

Drilled hole diameter	Single pass reaming minimum depth of cover	Multi-pass reaming minimum depth of cover
2 to 6 inches	4 feet	4 feet
> 6 inches to 22 inches	8 times the hole diameter	12 times the hole diameter
> 22 inches to 32 inches	15 feet	25 feet

Begin bores at locations that allow transitioning the bore to meet the above depths.

Use drilling fluids as appropriate for the type soils. Pump drilling fluids only while drilling or reaming. Monitor flow rates to match the amount leaving the bore hole. Do not increase pressure or flow to free stuck drillheads, reamers or piping.

Limit drilled or reamed holes to 2 inches larger than the pipe.

(C) Tunneling

Tunnel using hand mining or mechanical excavation. Use tunnel shields or fore-poling along with benched excavation and breast boarding as appropriate for the field conditions. Alternatively, the Contractor's Engineer may certify that the soils are self-supporting of the dead and live loads and design tunneling methods as appropriate.

Provide active support to the tunnel walls. Shore tunnel walls using liner plates, steel ribs with lagging, or other engineered method or by jacking piping into place.

Limit over excavation to 1 inch larger than the liner or shield. Grout the external voids as work progresses and as specified by the Contractor's Engineer.

(D) Pipe Ramming

Use pipe ramming only where soils are homogeneous and free of rock, boulders, stumps and debris. Do not use in the vicinity of quick or liquefiable soils.

Steel bands ½ inches thick are allowed on the outside of the leading edge of the pipe or casing to oversize the hole to reduce friction. Also, steel bands ½ inches thick may be used on the inside to compact the spoil and to prevent plugging.

Install at the following minimum depth of cover.

Pipe or casing diameter	Minimum depth of cover
2 to 6 inches	4 feet
> 6 to 14 inches	6 pipe diameters

>14 to 24 inches	8 feet

Contain spoil within the casing during ramming. After completion, use compressed air or augers to remove the spoil. Clean the interior using a pig. Provide appropriate safety devises. Limit air pressure to less than the rating of the pipe or casing.

Use lubricants and surfactants as needed.

(E) Other methods

Other methods will be considered on a case by case basis when thoroughly engineered.

(F) Lubrication and drilling fluids

Use drilling fluids for lubrication as needed at low pressure, low flow, and low volume. Do not use water alone. Low pressure is less than the weight of the soil above the excavation. Low flow is less than 1 gallon per minute. Low volume is less than the calculated annular space between the piping and excavated hole.

1550-5 QUALITY CONTROL

The Contractor at no cost to the Department shall replace or repair damaged or defective installations. The method to be used shall be designed by the Contractor's Engineer and approved by the Department's Engineer.

(A) Ground movement

Before excavation, establish control points for measuring settlement of the road at 10 foot intervals along the centerline and 10 feet each side of the pipeline. A licensed Land Surveyor shall monitor these points daily until construction is complete.

Cease trenchless operations when measured settlement exceeds 0.02 feet. Determine cause of settlement and repair as necessary. Modify trenchless methods as needed.

(B) Line and Grade

Abandon and grout all pipes that are not at required alignment and grade in conformance with Section 1530.

Trenchless installation of proposed water main may not vary more than 2% of total length from required horizontal alignment, one foot from vertical alignment, and shall maintain minimum cover.

Trenchless installations for grade and alignment dependent pipes such as sewers may not vary.

(C) Leakage

Control leakage through tunnel walls to minor seepage. Seal all leaks in pipes, casing, or other permanent shoring.

Roundness

Provide permanent shoring with at least 95% of nominal diameter in all directions.

(E) External voids

Fill all external voids greater than two inches high or two feet wide. Fill with compacted class II or III select material, flowable fill, or grout.

1550-6 METHOD OF MEASUREMENT

Trenchless Installation of _____ in Soil will be measured and paid in linear feet. Measurement will be made horizontally to the nearest tenth of a linear foot.

Trenchless installation of _____ Not in Soil will be measured and paid in linear feet. Measurement will be made horizontally to the nearest tenth of a linear foot.

Trenchless installations will be considered *In Soil* unless classified as *Not In Soil* by observation of the Engineer. *Not In Soil* is all material other than soil as determined and observed by the Department's Engineer. It is the Contractor's responsibility to request and obtain the Department's Engineer's observation for installations *Not In Soil*.

Measurement will be made along utility pipes with required trenchless installation. Payment for trenchless installation will be made as additional compensation for utility piping with contract pay items of the various sizes. No additional payment will be made for access pits or shoring. No payment will be made for abandoning defective installations.

Payment will be made under:

Pay Item	Pay Unit
Trenchless Installation of _____ in Soil	Linear Foot
Trenchless installation of _____ Not in Soil	Linear Foot

DIVISION 16
EROSION CONTROL AND ROADSIDE DEVELOPMENT

SECTION 1605
TEMPORARY SILT FENCE

1605-1 DESCRIPTION

Furnish material, construct, maintain, and remove temporary silt fence in locations shown on the plans or in locations that require surface drainage to be filtered.

1605-2 MATERIALS

(A) Posts

Provide steel post meeting the following requirements:

Minimum 5 feet long.
Minimum 1 3/8 inches wide measured parallel to the fence.
Minimum weight of 1.25 lb./ft of length.
Equipped with an anchor plate with minimum area of 14.0 square inches
Have a means of retaining wire and fabric in the desired position without displacement.

(B) Woven Wire Fence

Provide woven wire fence meeting the following requirements:

Minimum 32 inches high.
Minimum 5 horizontal wires.
Vertical wires spaced 12 inches apart.
Minimum 10 gauge top and bottom wires.
Minimum 12 1/2 gauge all other wires.

(C) Filter Fabric

Provide Type 3 engineering fabric, Class A or B meeting the requirements of Section 1056.

(D) Attachment Device

Provide No. 9 staple with a minimum length of 1 1/2 inches or other approved attachment device.

1605-3 INSTALLATION

Install in locations as shown on the plans or as directed.

Install wire and fabric as shown in Standard Drawings.

Class B synthetic filter fabric may be used without the woven wire fence backing, subject to the following conditions:

(A) The Engineer shall approve the fabric.

(B) Post spacing is inclined toward the runoff source, at an angle of not more than 20 degrees from vertical.

(1) Attach filter fabric to the wire fence with wire or other acceptable methods.

(2) Overlap filter fabric a minimum of 18 inches at splice joints.

(3) Install fabric that is free of defects, rips, holes, flaws, deterioration, or damage.

1605-4 MAINTENANCE AND REMOVAL

Maintain the silt fence until the project is accepted or until the fence is removed.

Remove and replace deteriorated or ineffective filter fabric.

Remove and dispose of silt accumulations in accordance with Section 1630 when necessary or as directed.

Leave silt fence in place until site stabilization and remove at project completion.

Removed silt fence becomes the property of the Contractor.

Dress and seed and mulch all areas where silt fence is removed in accordance with Section 1660.

1605-5 MEASUREMENT AND PAYMENT

Temporary Silt Fence will be measured and paid for in linear feet, accepted in place, along the ground line of the fence.

Silt Excavation will be measured and paid for in accordance with Section 1630.

Seeding and Mulching will be measured and paid for in accordance with Section 1660.

The requirements of Article 104-5 pertaining to revised contract prices for overrunning minor items will not apply to this item. No revision in the contract unit price will be allowed because of any overrun or underrun.

Payment will be made under:

Pay Item	Pay Unit
Temporary Silt Fence	Linear Foot

SECTION 1610
STONE FOR EROSION CONTROL

1610-1 DESCRIPTION

Furnish, stockpile if directed, place, and maintain an approved stone for construction of erosion control devices at ditches, diversions, swales, pipe inlets, pipe outlets, drainage

turnouts, and at other locations designated on the plans or as directed. The work includes but is not limited to furnishing, weighing, stockpiling, re-handling, placing, and maintaining stone; and disposal of any stone not incorporated into the project when necessary.

1610-2 MATERIALS

Refer to Division 10:

Item	Section
Stone for Erosion Control	1042-1
Sediment Control Stone	1005

1610-3 CONSTRUCTION METHODS

Place stone, in locations and to the thickness, widths, and lengths as shown on the plans or as directed. Construct erosion control devices in accordance with the plans neatly and uniformly with an even surface and meeting the requirements of the plans.

1610-4 MEASUREMENT AND PAYMENT

Stone For Erosion Control, Class __ will be measured and paid for in tons of each class of stone that has been incorporated into the work, or has been delivered to and stockpiled on the project as directed. Stone placed in the stockpile will not be measured a second time. Measure stone by weighing in trucks on certified platform scales or other certified weighing devices.

Sediment Control Stone will be measured and paid for in tons of stone that has been incorporated into the work, or has been delivered to and stockpiled on the project as directed. Stone placed in the stockpile will not be measured a second time. Measure stone by weighing in trucks on certified platform scales or other certified weighing devices.

Payment will be made under:

Pay Item	Pay Unit
Stone For Erosion Control, Class _____	Ton
Sediment Control Stone	Ton

SECTION 1615
TEMPORARY MULCHING

1615-1 DESCRIPTION

Furnish, place, and secure mulch material to prevent excessive soil erosion during construction operations where it is impossible or impractical to perform permanent seeding and mulching.

The actual conditions which occur during the construction of the project will determine the quantity of mulching. The quantity of mulching may be increased, decreased, or eliminated entirely as directed. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of work.

1615-2 MATERIALS

Refer to Division 10:

Item	Section
Mulch for Erosion Control	1060-5

Use undiluted emulsified asphalt or other approved tacking material.

1615-3 APPLICATION

Place temporary mulch promptly at locations on temporarily seeded or non-seeded areas when so directed.

Spread mulch uniformly over the area by hand or by means of appropriate mechanical spreaders or blowers to obtain a satisfactory uniform cover. A satisfactory application of temporary mulch on non-seeded areas consists of a sufficient amount to completely and uniformly cover the ground.

When temporary mulching is performed in conjunction with temporary seeding, apply mulch in accordance with Article 1660-6. Complete mulching and tacking within 24 hours. Exercise care to prevent displacement of soil and seed or other damage to areas where temporary seeding is done.

Apply a sufficient amount of asphalt or other type binding material when using grain straw to assure that the temporary mulch is properly held in place. Take adequate precautions to prevent damage to traffic, structures, guardrails, traffic control devices, or any other appurtenances during the application of binding material. Provide adequate covering or change methods of application as required to prevent such damage. Repair any damage that occurs, including any necessary cleaning.

Take sufficient precautions to prevent mulch from entering drainage structures through displacement by wind, water, or other causes and promptly remove any blockage to drainage facilities.

1615-4 MEASUREMENT AND PAYMENT

Temporary Mulching will be measured and paid in acres, measured along the surface of the ground over which temporary mulch has been placed as directed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Temporary Mulching	Acre

SECTION 1620
TEMPORARY SEEDING

1620-1 DESCRIPTION

Seed and mulch selected areas in advance of the permanent seeding and mulching operations to minimize erosion of graded areas during construction operations. The work includes preparing seedbeds; furnishing, placing, and covering fertilizer and seed; furnishing and placing mulch; and other operations necessary for seeding the required areas.

Perform temporary seeding promptly at the locations and under any of the following conditions when directed:

(A) When it is impossible or impractical to bring an area to the final line, grade, and finish so that permanent seeding and mulching operations can be performed without subsequent serious disturbance by additional grading;

(B) When erosion occurs or is considered to be potentially substantial on areas of graded roadbed where construction operations are temporarily suspended or where the grading of the roadbed has been completed substantially in advance of the paving construction;

(C) During seasons of the year when permanent seeding and mulching is prohibited by the contract;

(D) When an immediate cover would be desirable to minimize erosion, siltation, or pollution on any area.

The actual conditions that occur during the construction of the project will determine the quantity of seed or fertilizer to be used. The quantity of seed or fertilizer may be increased, decreased, or eliminated entirely as directed. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1620-2 MATERIALS

Refer to Division 10:

Item	Section
Fertilizer	1060-2
Seed	1060-4
Mulch for erosion control	1060-5

See the contract for analysis of fertilizer and the kinds of seed.

1620-3 SEEDBED PREPARATION

Scarify areas to be seeded to a depth of not less than 5 inches unless directed otherwise. The soil conditions and topography will determine the required depth of the seedbed.

Prepare the surface to be seeded with adequate furrows, ridges, terraces, trenches, or other irregularities in which seeding materials can lodge with reasonable assurance that the materials will not be easily displaced by wind, rain, or surface runoff.

1620-4 APPLYING AND COVERING FERTILIZER AND SEED

The analysis of fertilizer, the kinds of seed, and the rates of application of fertilizer and seed shall be as stated in the contract.

Apply no fertilizer or seed when the Engineer determines that conditions are unfavorable for such operations.

Distribute the fertilizer or seed uniformly over the seedbed at the required rates of applications.

Cover fertilizer and seed unless otherwise directed. If covering is required, provide it to the depth acceptable to the Engineer for the prevention of displacement by wind, rain, or surface runoff.

Mulch all areas temporarily seeded, in accordance with Section 1615, unless otherwise indicated in the contract or as directed.

The requirements of Article 1660-5 will be applicable to the approval of equipment; the use of liquid fertilizer; and the protection of traffic, structures, guardrails, traffic control devices, and other appurtenances.

1620-5 MOWING AND REPAIR OF TEMPORARY SEEDING

Maintain areas where temporary seeding is performed in a satisfactory condition, including mowing at the locations and times as directed.

Repair areas of temporary seeding which have been damaged or have failed. Repair includes reshaping or the placing of additional earth material and repeating the seeding process.

1620-6 MEASUREMENT AND PAYMENT

Seed For Temporary Seeding will be measured and paid for in pounds. The weight of seed will be determined by bag count of standard weight bags or by weighing the seed on certified platform scales or other certified weighing devices.

Fertilizer For Temporary Seeding will be measured and paid for in tons. The weight of dry fertilizer will be determined by bag count of standard weight bags, or by weighing the fertilizer in trucks on certified platform scales or other certified weighing devices. The weight of liquid fertilizer will be the equivalent weight in tons of dry fertilizer based on available plant food.

Temporary Mulching will be measured and paid for in accordance with Section 1615.

Mowing will be measured and paid for in accordance with Section 1660.

Where earthwork and temporary seeding have been adequately constructed, completely drained, and properly maintained, and damage occurs due to natural causes, the Contractor will be paid at the contract unit price for the excavated material required for repairs to the

damaged earthwork, and the contract unit prices for *Seed For Temporary Seeding* and *Fertilizer for Temporary Seeding* for correcting the damaged temporary seeding.

Repair, at no cost to the Department, any damage to earthwork or temporary seeding which is due to carelessness or neglect on the part of the Contractor.

Payment will be made under:

Pay Item	Pay Unit
Seed For Temporary Seeding	Pound
Fertilizer For Temporary Seeding	Ton

SECTION 1622
TEMPORARY SLOPE DRAINS

1622-1 DESCRIPTION

Furnish, place, maintain and remove temporary slope drains at the locations shown on the plans and at locations as directed. Work includes but is not limited to furnishing all pipe, anchor stakes, and compacted earth; installation and removal of the slope drain; furnishing and installation of asphalt plant mix and stone; constructing the sump, earth shoulder berm and earth berm ditch block; constructing the outlet protection; and dressing, seeding, and mulching the disturbed area after the slope drain and berm have been removed.

The actual conditions during the construction of the project will determine the quantity of temporary slope drains.

The quantity of temporary slope drains may be increased, decreased, or eliminated entirely at the direction of the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1622-2 MATERIALS

Provide temporary slope drains with pipe of sufficient size to carry the anticipated volume of water with a minimum diameter of 12 inches. Provide plastic pipe and fittings meeting the requirements of AASHTO M294.

Refer to Division 10:

Item	Section
Asphalt Plant Mix	1012-1, 1020-2, 1020-8
Stone	1042-1

1622-3 CONSTRUCTION METHODS

(A) Temporary Slope Drains

Install temporary slope drains in accordance with the Standard Drawings during all phases of grading operations and adjust as needed to properly direct water flow.

Construct an earth berm at the top of cut and fill sections to direct water flow into temporary slope drains.

At locations of single direction waterflow, locate temporary slope drain inlets in a sump along the earth berm. Construct an earth berm ditch block perpendicular to the direction of the waterflow on the downstream side of the temporary slope drain. Construct ditch blocks of sufficient height to block the flow of water but at no higher elevation than the earth shoulder berm.

Join multiple pipe sections using an approved pipe coupling. Anchor slope drains in accordance with the Standard Drawings.

Remove temporary slope drains as directed. Temporary slope drains become the property the Contractor when removed. Dress the area to blend with existing contours, and seed and mulch in accordance with Section 1660.

(B) Inlet Protection at Temporary Slope Drain:

Protect the inlet by compacting earth material or lining the inlet area with Class B stone, asphalt plant mix, or other acceptable material in accordance with the details in the plans. Construct either an appropriately sized Type B basin or a Pipe Inlet Sediment Trap Type A at the inlet of the temporary slope drain to provide adequate sediment storage.

Provide asphalt plant mix meeting the requirements of Section 610.

A prime coat or tack coat is not required.

Pavers are not required for spreading and finishing.

Compact mix to an acceptable degree.

(C) Outlet Protection at Temporary Slope Drain

Protect outlet locations subject to scour by placing Class B stone or a silt detention device. Construct outlet protection devices as shown on the plans and at other locations as directed.

1622-4 MEASUREMENT AND PAYMENT

Temporary Slope Drains will be measured and paid for in linear feet of pipe including inlets, measured along the invert of the temporary slope drain, that has been completed and accepted.

Inlet Protection at Temporary Slope Drain will be measured and paid for in units of each.

Stone For Erosion Control, Class ___ will be measured and paid for in accordance with Section 1610.

No payment will be made for temporary slope drains or inlet protection, that were required due to the Contractor's negligence, carelessness, or failure to install permanent controls as a part of the work scheduled.

Temporary Slope Drains and *Inlet Protection at Temporary Slope Drain* will be considered minor items. The requirements of Article 104-5 pertaining to revised contract unit prices for overrunning minor items will not apply to these items.

Payment will be made under:

Pay Item	Pay Unit
Temporary Slope Drains	Linear Foot
Inlet Protection at Temporary Slope Drain	Each

SECTION 1630
CONSTRUCTION AND MAINTENANCE OF SILT DETENTION DEVICES

1630-1 DESCRIPTION

Excavate and satisfactorily dispose of all materials excavated in the construction, cleaning out, and maintenance of silt basins, silt ditches, and other silt detention devices. Work includes but is not limited to excavation, shaping of the basins or ditches, cleaning out and maintaining the basins or ditches, disposal of all materials, and backfilling.

1630-2 GENERAL

Excavate silt basins, silt ditches, or other silt detention devices to the dimensions and at the locations shown on the plans or as directed for the purpose of siltation control. Clean out silt detention devices, when so directed, in order to maintain their effectiveness. Backfill and shape for seeding and mulching silt detention basins and silt ditches prior to completion of the project unless otherwise directed.

1630-3 DISPOSAL OF MATERIALS

Utilize all excavated materials in the construction of roadway embankments except where otherwise directed. Dispose of materials, which are not utilized in the construction of roadway embankments in waste areas in accordance with Section 802.

1630-4 MEASUREMENT AND PAYMENT

Silt Excavation will be measured and paid for in cubic yards measured in the original position, of all materials excavated within the limits established by the plans or directed by the Engineer. If in the opinion of the Engineer it is not feasible to measure the excavated material in its original position, the volume will be determined by truck measurement in accordance with Subarticle 230-5(C), except that no deduction for shrinkage will be made.

The filling of silt basins or silt ditches will be paid for as provided in Section 225 for Unclassified Excavation or in Section 230 for Borrow Excavation, depending on the source of the material used to fill the basins or ditches.

Payment will be made under:

Pay Item	Pay Unit
Silt Excavation	Cubic Yard

SECTION 1631
DITCH LINER AND EROSION CONTROL BLANKETS

1631-1 DESCRIPTION

Furnish, place, and maintain a ditch liner and/or erosion control blanket of synthetic roving or matting for erosion control on previously shaped and seeded drainage ditches, slopes, or other areas at locations shown in the contract or as directed. Work includes providing all materials; excavation and backfilling; placing synthetic roving; applying asphalt material; placing and securing matting; and maintaining the drainage ditch.

The conditions which occur during the construction of the project will determine the quantity of synthetic roving and matting placed. The quantity of matting may be increased, decreased, or eliminated entirely as directed. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1631-2 MATERIALS

Refer to Division 10:

Item	Section
Synthetic Roving	1054-5
Matting for Erosion Control	1060-8
Staples	1060-8

Provide wooden stakes meeting the following requirements:

Minimum 12 inches long.

Minimum 1 inch x 2 inch nominal dimension.

Use undiluted emulsified asphalt for tacking material on synthetic roving.

1631-3 CONSTRUCTION METHODS

(A) Synthetic Roving

Place synthetic roving immediately following seeding. Provide a smooth soil surface free from stones, clods, or debris which will prevent the contact of the fibers with the soil. Preserve the required line, grade, and cross section of the area covered.

Apply synthetic roving uniformly over the designated area to form a random mat of continuous fibers at the rate of 0.25 to 0.35 pounds per square yard of fiberglass roving or 0.15 to 0.20 pounds per square yard of polypropylene roving. Apply

tacking material over the fibers immediately after the roving is placed at a rate of 0.25 to 0.35 gallons per square yard.

Bury roving to a depth of 5 inches at the upgrade end and at maximum intervals of 50 feet along the ditches. Install wooden stakes at the upgrade end and in an irregular pattern to securely hold the roving, no more than 10 feet apart, throughout the ditch.

(B) Matting

Place matting immediately following seeding. Provide a smooth soil surface free from stones, clods, or debris that will prevent the contact of the matting with the soil. Preserve the required line, grade, and cross section of the area covered.

Unroll matting in the direction of the flow of water, and apply without stretching so that it will lie smoothly but loosely on the soil surface. Bury the up-channel or top of slope end of each piece of matting in a narrow trench at least 5 inches deep and tamp firmly. Where one roll of matting ends and a second-roll begins, overlap the end of the upper roll over the buried end of the second roll so there is a 6 inch overlap. Construct check trenches at least 12 inches deep every 50 feet longitudinally in the matting or as directed. Fold over and bury matting to the full depth of the trench, and close and tamp firmly. Overlap matting at least 4 inches where 2 or more widths of matting are laid side by side.

Place staples across matting at ends, junctions, and check trenches approximately 10 inches apart.

Place staples along the outer edges and down the center of each strip of matting 3 feet apart. Place staples along all lapped edges 2 to 3 inches apart.

Install product with netting on the top side when excelsior or straw matting is used.

The Engineer may require adjustments in the trenching or stapling requirements to fit individual cut or fill slope conditions.

1631-4 MEASUREMENT AND PAYMENT

Synthetic Roving will be measured and paid in square yards as measured along the surface of the ground, over which synthetic roving has been acceptably placed.

Matting will be measured and paid in square yards as measured along the surface of the ground, over which matting has been acceptably placed.

Payment will be made under:

Pay Item	Pay Unit
Synthetic Roving	Square Yard
Matting For Erosion Control	Square Yard

SECTION 1632
ROCK INLET SEDIMENT TRAP

1632-1 DESCRIPTION

Construct, maintain and remove devices around catch basins and/or drop inlets to reduce water velocity and contain sediment. Work includes furnishing all fence posts, hardware cloth, hardware, stone and other materials, installing and maintaining the 1/4 inch hardware cloth.

The actual conditions which occur during the construction of the project will determine the quantity of rock inlet sediment traps constructed. The quantity of inlet sediment traps may be increased, decreased, or eliminated entirely as directed. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1632-2 MATERIALS

(A) Steel Posts

Meet the following requirements:

Minimum 5 feet long.
Minimum 1 3/8 inches wide measured parallel to the fence.
Minimum weight of 1.25 lb./ft of length.
Equipped with an anchor plate with minimum area of 14.0 square inches.
Have a means of retaining wire in the desired position without displacement.

(B) Wire Staples

Provide No. 9 staple with a minimum length of 1 1/2 inches.

(C) 1/4 inch hardware cloth

Provide hardware cloth having 1/4 inch openings constructed from 24 gauge wire (0.026 inch diameter) or larger, and having a minimum width of 24 inches as specified in ASTM A-740.

(D) Other Materials

Refer to Division 10:

Item	Section
Stone for Erosion Control, Class ____	1042-1
Sediment Control Stone	1005

1632-3 CONSTRUCTION

(A) Type A

Place structural stone (Class B stone) around the outside perimeter of the inlet structure with approximately 2:1 side slopes, and plate the upstream side with sediment control stone.

(B) Type B

Place structural stone (Class A stone) around the outside perimeter of the inlet structure with approximately 2:1 side slopes, and plate the upstream side with sediment control stone.

(C) Type C

Construct rock inlet sediment trap type-C devices as shown on the plans and at other locations as directed.

1632-4 MAINTENANCE AND REMOVAL

Maintain the rock inlet sediment trap, and remove and dispose of silt accumulations at the inlet sediment traps when necessary or as directed in accordance with Section 1630.

Remove rock inlet sediment traps as the project nears completion, or as directed. Dress the area to blend with existing contours, and seed and mulch the area in accordance with Section 1660.

1632-5 MEASUREMENT AND PAYMENT

Payment for rock inlet sediment traps will be made as follows:

1/4 inch hardware cloth will be measured and paid in linear feet of hardware cloth, measured in place from end post to end post at each separate installation that has been completed and accepted.

Stone for Erosion Control, Class ____ will be measured and paid in accordance with Section 1610.

Sediment Control Stone will be measured and paid in accordance with Section 1610.

Silt Excavation will be measured and paid for in accordance with Section 1630.

Payment will be made under:

Pay Item	Pay Unit
1/4" Hardware Cloth	Linear Foot

SECTION 1633
TEMPORARY ROCK SILT CHECKS

1633-1 DESCRIPTION

Construct, maintain, and remove devices placed in ditches, diversions or swales to reduce water velocity and contain sediment.

The actual conditions which occur during the construction of the project will determine the quantity of temporary rock silt checks constructed. The quantity of silt check dams may be increased, decreased, or eliminated entirely as directed. Such variations in quantity will

not be considered as alterations in the details of construction or a change in the character of the work.

1633-2 MATERIALS

Refer to Division 10:

Item	Section
Stone for Erosion Control, Class ____	1042-1
Sediment Control Stone	1005

1633-3 CONSTRUCTION

(A) Type A

Place structural stone in the channel, ditch, diversion or swale with approximately 2:1 side slopes. Place sediment control stone, approximately 12 inches thick on the upstream side.

(B) Type B

Construct temporary rock silt check type-B devices as shown on the plans and at other locations as directed.

1633-4 MAINTENANCE AND REMOVAL

Maintain the temporary rock silt checks, and remove and dispose of silt accumulations at the silt checks when so directed in accordance with Section 1630.

Remove temporary rock silt checks as the project nears completion. The actual time of removal will be as directed. After removal of silt checks, dress the area to blend with existing contours and seed and mulch the area in accordance with Section 1660.

1633-5 MEASUREMENT AND PAYMENT

Payment for *temporary rock silt checks* will be as follows:

Stone for Erosion Control, Class ____ will be measured and paid in accordance with Section 1610.

Sediment Control Stone will be measured and paid in accordance with Section 1610.

Silt Excavation will be measured and paid for in accordance with Section 1630.

SECTION 1634
TEMPORARY ROCK SEDIMENT DAMS

1634-1 DESCRIPTION

Construct, maintain, and remove devices placed in ditches, diversions, swales, or drainage turnouts to reduce water velocity and contain sediment.

The actual conditions which occur during the construction of the project will determine the quantity of temporary rock sediment dams constructed. The quantity of rock sediment dams may be increased, decreased, or eliminated entirely as directed. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1634-2 MATERIALS

Refer to Division 10:

Item	Section
Stone for Erosion Control, Class ____	1042-1
Sediment Control Stone	1005

1634-3 CONSTRUCTION

(A) Type-A

Place structural stone in the channel, ditch diversion, swale, or drainage turnouts with 2:1 side slope on the upstream side and 3:1 side slope on the downstream side. Plate the upstream side with sediment control stone approximately 12 inches thick.

Provide a weir section approximately 2/3 of the channel width and with an 8 foot maximum height from the bottom of the channel. Place the weir section approximately 12 inches lower than the sides of the device or the top of the channel, whichever is lower located in the center of the device.

(B) Type-B

Place structural stone in the channel, ditch diversion, swale, or drainage turnouts with 2:1 side slopes and plate the upstream side with sediment control stone approximately 12 inches thick.

Provide a weir section with a 4 foot minimum width constructed 18 inches lower than the sides of the device or the top of the channel, whichever is lower) located in the center of the device.

Construct the temporary rock sediment dam type-B with a 5 foot minimum thickness measured along the top of the dam structure. Construct the structural stone apron approximately 8 foot long with a 2 foot depth.

Use earthen backfill material to extend dam width and create a larger sediment storage volume for the temporary rock sediment dam type-B where needed.

1634-4 MAINTENANCE AND REMOVAL

Maintain the temporary rock sediment dams, and remove and dispose of silt accumulations at the sediment dams when so directed.

Remove temporary rock sediment dams as the project nears completion, or at such time as the Engineer deems the device to be no longer useful. The Engineer will direct the actual time of removal. Dress seed and mulch the area in accordance with Section 1660.

1634-5 MEASUREMENT AND PAYMENT

Payment for *temporary rock sediment dams* will be made as follows:

Stone for Erosion Control, Class ____ will be measured and paid in accordance with Section 1610.

Sediment Control Stone will be measured and paid in accordance with Section 1610.

Silt Excavation will be measured and paid for in accordance with Section 1630.

SECTION 1635
ROCK PIPE INLET SEDIMENT TRAP

1635-1 DESCRIPTION

Construct, maintain and remove devices placed around outside perimeters of pipe structures, to reduce water velocity and trap sediment.

The conditions which occur during the construction of the project will determine the quantity of temporary rock pipe inlet sediment traps to be constructed. The quantity of inlet sediment traps may be increased, decreased, or eliminated entirely as directed. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1635-2 MATERIALS

Refer to Division 10:

Item	Section
Stone for Erosion Control, Class ____	1042-1
Sediment Control Stone	1005

1635-3 CONSTRUCTION

(A) Type A

Construct rock pipe inlet sediment trap type-A devices at locations shown on the plans or as directed.

(B) Type B

Construct rock pipe inlet sediment trap type-B devices at locations shown on the plans or as directed.

1635-4 MAINTENANCE AND REMOVAL

Maintain the rock pipe inlet sediment traps, and remove and dispose of silt accumulations at the pipe inlet sediment traps as directed in accordance with Section 1630.

Remove rock pipe inlet sediment traps as the project nears completion, or as directed. Dress the area to blend with existing contours and seed and mulch in accordance with Section 1660.

1635-5 MEASUREMENT AND PAYMENT

Payment for temporary rock pipe inlet sediment traps will be as follows:

Stone for Erosion Control, Class ____" will be measured and paid for in accordance with Section 1610.

Sediment Control Stone will be measured and paid for in accordance with Article 1610.

Silt excavations will be measured and paid for in accordance with Section 1630.

SECTION 1637
RISER BASIN

1637-1 DESCRIPTION

Construct, maintain, and remove riser basin devices to reduce water velocity and contain sediment.

The actual conditions which occur during the construction of the project will determine the quantity of riser basin devices constructed. The quantity of riser basins may be increased, decreased, or eliminated entirely as directed. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1637-2 MATERIALS

All materials shall meet the following requirements:

Item	Section
Perforated C.S. Pipe Tee riser	310
Sediment Control Stone	1005

1637-3 CONSTRUCTION

Work includes constructing earth embankments and overflow spillways, and installing outlet pipe, perforated tee-riser sections, trash racks, and anti-flotation devices in silt basins. Use either anti-flotation method shown on the plans.

Construct earth embankments with 2:1 side slopes with material meeting roadway embankment Specifications. Maximum height of earth embankments shall be 12 feet. Compact embankment as directed. Excavate when required to provide minimum surface area and/or minimum storage volume area measured below the top of the principal spillway (top of the riser pipe).

Install a perforated C.S. pipe tee riser as specified on the plans. Place 3/8 inch holes on 3 inch centers on the riser pipe and face the riser pipe with sediment control stone. Additional C.S. pipe may be required to obtain the required riser pipe height (crest elevation) as indication on the plans. Construct a trash rack and an anti-flotation device on the riser pipe.

Construct an overflow spillway outlet, on natural ground, 1 foot above riser pipe. Plate overflow spillway with Erosion Control Stone Class B as specified on the plans.

Stabilize the embankment and surrounding areas with vegetation after installation.

1637-4 MAINTENANCE AND REMOVAL

Place a marker in the basin indicating the 50% volume level. Clean out riser basin when sediment volume reaches 50% of the storage volume in accordance with Section 1630.

Remove riser basin devices as the project nears completion or as directed. Dress, seed and mulch the area in accordance with Section 1660 after removal of the riser basin.

1637-5 MEASUREMENT AND PAYMENT

Stone for Erosion Control, Class B will be measured and paid in accordance with Section 1610.

Sediment Control Stone will be measured and paid in accordance with Section 1610.

Silt Excavation will be measured and paid in accordance with Section 1630.

Perforated C.S. Pipe Tee Riser, __" Thick will be measured and paid for in units of each that has been installed and accepted. Such price shall include furnishing and installing any additional pipe required for correct riser height, the trash rack, and the anti-flotation device.

Outlet Pipe will measured and paid in accordance with Section 310.

Silt Excavation will be measured and paid in accordance with Section 1630.

Payment will not be made for any work performed under this section that is solely for the convenience of the Contractor or that is made necessary due to negligence of the Contractor.

Payment will be made under:

Pay Item	Pay Unit
__" x __" x __" Perforated C.S. Pipe Tee Riser, __" Thick	Each

SECTION 1638
STILLING BASIN

1638-1 DESCRIPTION

Construct, maintain, and remove earth embankments used to trap sediment from dewatering construction sites. Work includes providing permeable stone drain, cleaning out, maintaining, removing and disposing of the stilling basins and all components and reshaping the area.

The actual conditions that occur during the construction of the project will determine the quantity of stilling basins constructed. The quantity of stilling basins may be increased, decreased, or eliminated entirely as directed. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1638-2 MATERIALS

Utilize suitable excavated materials, as specified in Sections 225, 230, and 240, in the construction of earth embankments for stilling basins, except where otherwise specified.

Item	Section
Stone for Erosion Control Class ____	1042-1
Sediment Control Stone	1005

1638-3 CONSTRUCTION

Construct stilling basins at the locations shown on the plans and at other locations as directed.

Construct earth embankment with a permeable stone drain in a rectangular form adjacent to the stream and culvert following the applicable requirements of Section 235. The maximum height allowed for earth dikes is five feet. Excavate below the natural ground for greater depths of basins.

Use a minimum of three coir fiber baffles as directed by the standard drawing.

1638-4 MAINTENANCE AND REMOVAL

Maintain the stilling basins, coir fiber baffles, and remove and dispose of silt accumulations at the stilling basins in accordance with Section 1630.

Remove the stilling basins as the project nears completion, or at such time the Engineer deems the device to be no longer useful. Dress and seed and mulch the area after removal of the stilling basin in accordance with Section 1660.

1638-5 MEASUREMENT AND PAYMENT

Stilling Basin quantities will be measured and paid for in cubic yards, in place and computed by the average-end-method for the actual number of cubic yards of basin capacity. The measurements will be the internal measurements of the basin measured up to the top of the permeable stone drain. Materials used to construct the basin that originates from another payment item (i.e. unclassified excavation, borrow excavation) will not be deducted from the volume of that original pay item.

Payment will be made under:

Pay Item	Pay Unit
Stilling Basins	Cubic Yard

SECTION 1650
WOODED AREA CLEANUP

1650-1 DESCRIPTION

Remove and satisfactorily dispose of debris and of dead, partially dead, or broken vegetation from wooded areas of the right of way outside clearing limits, and from other areas outside construction limits on which seeding and mulching is not to be performed. Work includes treating stumps with herbicide, and repairing any damage to vegetation.

Cutover timberland, reforested areas, or thickets of young native volunteer vegetation will be considered to be wooded areas.

1650-2 MATERIALS

Refer to Division 10:

Item	Section
Herbicide	1060-13

1650-3 CONSTRUCTION REQUIREMENTS

Remove all logs, stumps, snags, loose roots, down timber, slabs, tree laps, lumber, dead or partially dead trees, broken trees or brush, dead brush, sawdust piles, discarded fences, leaf piles, brick, tile masonry, and other debris from the cleanup areas. Cut, all dead trees, stumps, snags, broken or partially dead trees, and brush, flush with the ground. Remove vegetation which dies between initial cleanup and completion of the project prior to final acceptance. Hand raking of areas or removal of a normal leaf layer is not required unless stated in the contract.

Treat partially dead stumps or broken vegetation with a herbicide immediately after cutting. Use the herbicide and the method and rate of application, specified in the contract. Follow all applicable instructions, warnings, and safety precautions stated on the manufacturer's label, and comply with all laws and regulations governing herbicides that are in effect at the time of use.

Dispose of all material cleaned up under this item in accordance with the applicable requirements of Article 200-5 and Article 802-2.

1650-4 DAMAGE TO REMAINING VEGETATION

Conduct operations in such a manner as to prevent injury to trees, shrubs, or other types of vegetation that are to remain growing, and also to prevent damage to adjacent property.

Remove broken branches and rough edges of scarred trees or shrubs. Prune and shape these areas in accordance with the International Society of Arborbiculture pruning techniques. Cut and dispose of any plants that are damaged beyond their value for landscape purposes and seed and mulch vegetation that is damaged by the Contractor at no cost to the Department when so directed.

1650-5 MEASUREMENT AND PAYMENT

Wooded Area Cleanup will be measured and paid for in acres, measured horizontally, completed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Wooded Area Cleanup	Acre

SECTION 1651
SELECTIVE VEGETATION REMOVAL

1651-1 DESCRIPTION

Remove selected living trees and undesirable living undergrowth from areas of the right of way outside clearing limits in accordance with these Specifications. Work includes treating stumps with herbicide, and repairing any damage to vegetation.

1651-2 MATERIALS

Refer to Division 10:

Item	Section
Herbicide	1060-13

1651-3 CONSTRUCTION REQUIREMENTS

(A) Trees

Remove trees shown on the plans or designated. Measure all tree diameter sizes at a height of 4 feet 6 inches above the ground.

(B) Undergrowth

Remove all undergrowth from areas shown on the plans, described in the Specifications, or designated, except for those plants designated to be preserved. All plants less than 4 inches in diameter, measured at a height of 4 feet 6 inches above the ground shall be classified as undergrowth.

(C) General

Treat stumps with a herbicide immediately after cutting to prevent sprouting. Use the herbicide and the method and rate of application specified in the Specifications. Follow all applicable instructions, warnings, and safety precautions stated on the manufacturer's label, and comply with all laws and regulations governing herbicides that are in effect at the time of use.

When work is performed properly in accordance with these Specifications, no subsequent re-cutting of sprouts or seedling growth will be required.

Dispose of all trees and undergrowth cut in accordance with the applicable requirements of Article 200-5.

1651-4 DAMAGE TO REMAINING VEGETATION

Conduct operations so as to prevent injury to trees, shrubs, or other types of vegetation that are to remain growing, and also to prevent damage to adjacent property.

Remove broken branches and rough edges of scarred trees or shrubs. Shape and make smooth these areas in accordance with generally accepted horticultural practice. Cut and dispose of any plants that are damaged beyond their value for landscape purposes and seed and mulch vegetation that is damaged by the Contractor at no cost to the Department.

1651-5 MEASUREMENT AND PAYMENT

Selective Tree Removal __" will be measured and paid for in units of each. Each tree removed will be paid for at the contract unit price for the pay item size applicable to the actual tree diameter, measured at a height of 4 feet 6 inches above the ground, as indicated in Table 1651-1 below.

TABLE 1651-1
PAY ITEM SIZES

Pay Item Size	Actual Tree Diameter
6 inch	4 inches up to 8 inches
10 inch	8 inches up to 12 inches
15 inch	12 inches up to 18 inches
18 inches	18 inches and over

Selective Undergrowth Removal will be measured and paid in acres, measured horizontally, which has been completed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Selective Tree Removal, 6"	Each
Selective Tree Removal, 10"	Each
Selective Tree Removal, 15"	Each
Selective Tree Removal, 18"	Each
Selective Undergrowth Removal	Acre

SECTION 1660
SEEDING AND MULCHING

1660-1 DESCRIPTION

Prepare seedbed; furnish, place, and incorporate limestone, fertilizer, and seed; compact seedbed; furnish, place, and secure mulch; mow; and perform other operations necessary for the permanent establishment of vegetation from seed on shoulders, slopes, ditches, or other roadside areas.

Perform seeding and mulching on all earth areas disturbed by construction and on portions of areas seeded under previous contracts as directed where there is unsatisfactory vegetative cover.

Adapt operations to variations in weather or soil conditions as necessary for the successful establishment and growth of the grasses or legumes.

Preserve the required line, grade, and cross section of the area treated.

The actual conditions which occur during the construction of the project will determine the quantity of mowing. The quantity of mowing may be increased, decreased, or eliminated entirely as directed. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1660-2 MATERIALS

Refer to Division 10:

Item	Section
Fertilizer	1060-2
Limestone	1060-3
Seed	1060-4
Mulch for Erosion Control	1060-5

Use undiluted emulsified asphalt for tacking material.

The analysis of fertilizer and the kinds of seed will be as stated in the contract.

1660-3 COORDINATION WITH GRADING OPERATIONS

Perform seeding and mulching operations on a section by section basis immediately upon completion of earthwork sections in accordance with the requirements of Article 225 - 2.

When grading operations have been suspended, and seeding and mulching has been performed on areas where work has been suspended, include in the work of seeding and mulching of the adjacent sections any necessary overlapping of operations on previously established vegetative cover.

When the Contractor fails or neglects to coordinate grading with seeding and mulching operations and to diligently pursue the control of erosion and siltation, the Engineer may suspend the Contractor's grading operations until such time as the work is coordinated in a manner acceptable to the Engineer. Such suspension will be in accordance with the requirements of Article 108-7.

1660-4 SEEDBED PREPARATION

Cut and satisfactorily dispose of weeds or other unacceptable growth on the areas to be seeded. Shape and smooth uneven and rough areas outside of the graded section, such as crop rows, farm contours, ditches and ditch spoil banks, fence line and hedgerow soil accumulations, and other minor irregularities which cannot be obliterated by normal seedbed preparation operations, to provide for more effective seeding and for ease of subsequent mowing operations.

Scarify or otherwise loosen the soil to a depth of not less than 5 inches except as otherwise provided below or otherwise directed. Break clods and work the top 2 to 3 inches of soil into an acceptable seedbed by the use of soil pulverizers, drags, or harrows; or by other approved methods. Remove all rock and debris 3 inches or larger on median,

shoulder, and ditch cut or fill slopes which are 3:1 or flatter, prior to the application of seed and fertilizer. Remove rock 6 inches and larger displaced during seeding operations.

Scarify, groove, trench, or puncture all slope surfaces. The depth of preparation and the degree of smoothness of the seedbed may be reduced on cut slopes that are 2:1 and steeper, as permitted by the Engineer.

On cut slopes that are either 2:1 or steeper, the Engineer may permit the preparation of a partial or complete seedbed during the grading of the slope. If at the time of seeding and mulching operations such preparation is still in a condition acceptable to the Engineer, additional seedbed preparation may be reduced or eliminated.

Limit seedbed preparation to within 2 feet of the edge of any pavement to a depth of 2 to 3 inches.

Do not prepare seedbed when the soil is frozen, extremely wet, or when the Engineer determines that it is an otherwise unfavorable working condition.

1660-5 APPLYING AND COVERING LIMESTONE, FERTILIZER, AND SEED

(A) General

The contract will state the seasonal limitation for seeding operations; the kinds of grades of fertilizers; the kinds of seed; and the rates of application of limestone, fertilizer, and seed.

Obtain approval from the Engineer before using equipment for the application, covering, or compaction of limestone, fertilizer, and seed. Approval may be revoked at any time if equipment is not maintained in satisfactory working condition, or if the equipment operation damages the seed.

Apply limestone, fertilizer, and seed within 24 hours after completion of seedbed preparation unless otherwise permitted by the Engineer. When the Engineer determines that weather and soil conditions are unfavorable, do not distribute any limestone or fertilizer and do not sow any seed.

Take adequate precautions to prevent damage to traffic, structures, guardrails, traffic control devices, or any other appurtenances during the application of fertilizer. Provide adequate covering or change methods of application as required to avoid such damage. Repair any damage that occurs, including any cleaning that may be necessary.

(B) Limestone and Fertilizer

Limestone may be applied as a part of the seedbed preparation, provided it is immediately worked into the soil. If not so applied, distribute limestone and fertilizer uniformly over the prepared seedbed at the specified rate of application and then harrow, rake, or otherwise thoroughly work or mix into the seedbed.

If liquid fertilizer is used, locate storage containers for the liquid fertilizer on the project and equip for agitation of the liquid prior to its use. Equip the storage containers with approved measuring or metering devices which will enable the Engineer to record at any time the amount of liquid that has been removed from the container. Calibrate application equipment for liquid fertilizer, other than a hydraulic seeder, to ensure that the required rate of fertilizer is applied uniformly.

(C) Seed

Distribute seed uniformly over the seedbed at the required rate of application, and immediately harrow, drag, rake, or otherwise work so as to cover the seed with a layer of soil. Cover to a depth as directed by the Engineer. If 2 kinds of seed are to be used which require different depths of covering, sow separately.

When a combination seed and fertilizer drill is used, drill fertilizer with seed after applying and incorporating limestone into the soil. If using two kinds of seed requiring different depth of cover, the seed requiring the lighter cover may be sown broadcast or with a special attachment to the drill, or drilled lightly following the initial drilling operation.

When using a hydraulic seeder for application of seed and fertilizer, do not allow the seed to remain in water containing fertilizer for more than 30 minutes prior to application unless otherwise permitted.

Compact the seedbed immediately after seed has been properly covered in the manner and degree approved by the Engineer.

(D) Modifications

When adverse seeding conditions are encountered due to steepness of slope, height of slope, or soil conditions, the Engineer may direct or permit that modifications be made in the above requirements which pertain to incorporating limestone into the seedbed; covering limestone, seed, and fertilizer; and compaction of the seedbed.

Such modifications may include but not be limited to the following:

(1) The incorporation of limestone into the seedbed may be omitted on
   (a) cut slopes steeper than 2:1
   (b) on 2:1 cut slopes when a seedbed has been prepared during the excavation of the cut and is still in an acceptable condition; or
   (c) on areas of slopes where the surface of the area is too rocky to permit the incorporation of the limestone.

(2) The rates of application of limestone, fertilizer, and seed on slopes 2:1 or steeper or on rocky surfaces may be reduced or eliminated.

(3) Compaction after seeding may be reduced or eliminated on slopes 2:1 or steeper, on rocky surfaces, or on other areas where soil conditions would make compaction undesirable.

1660-6 MULCHING

(A) General

Mulch all seeded areas unless otherwise indicated in the contract or directed by the Engineer.

Use grain straw as mulch at any time of the year. If permission to use material other than grain straw is requested and the use of such material is approved by the Engineer, the seasonal limitations, the methods and rates of application, the type of

binding material, or other conditions governing the use of such material will be established by the Engineer at the time of approval.

(B) Applying Mulch

Apply mulch within 24 hours after completion of seeding unless otherwise permitted. Exercise care to prevent displacement of soil or seed or other damage to the seeded area during the mulching operations.

Spread mulch uniformly by hand or by approved mechanical spreaders or blowers which will provide an acceptable application. An acceptable application will be that which will allow some sunlight to penetrate and air to circulate but also partially shade the ground, reduce erosion, and conserve soil moisture.

(C) Holding Mulch

Hold mulch in place by applying a sufficient amount of undiluted emulsified asphalt or other approved binding material. The Engineer will approve the rate and method of application of binding material. Apply the binding material directly with the mulch or immediately following the mulch application.

Take adequate precautions to prevent damage to traffic, structures, guardrails, traffic control devices, or any other appurtenances during the application of asphalt binding material. Provide adequate covering or change methods of application as required to avoid such damage. Repair any damage that occurs, including any cleaning that may be necessary.

Take sufficient precautions to prevent mulch from entering drainage structures through displacement by wind, water, or other causes and promptly remove any blockage to drainage facilities which may occur.

1660-7 MAINTENANCE OF SEEDING AND MULCHING

Maintain areas where seeding and mulching have been performed in a satisfactory condition until final acceptance of the project.

Mow at the location and times as directed.

Correct areas of damage or failure due to any cause by repairing or completely reworking as directed.

Repair in accordance with Section 1661 where extensive seedbed preparation is unnecessary.

Rework seeding and mulching in accordance with this section where correction requires extensive seedbed preparation, or where earthwork repairs or complete reshaping are necessary.

As an exception to the above, repair areas of damage or failure resulting either from negligence on the part of the Contractor in performing subsequent construction operations or from not taking adequate precautions to control erosion and siltation as required throughout the various sections of the Specifications, at no cost to the Department.

1660-8 MEASUREMENT AND PAYMENT

Seeding and mulching will be measured and paid for in acres, measured along the surface of the ground that has been completed and accepted. No direct payment will be made for furnishing and applying the limestone and fertilizer as such work and materials will be considered to be incidental to be the work covered by *Seeding and Mulching.*

Mowing will be measured and paid for in acres measured along the surface of the ground, that has been mowed as directed. Where an area has been mowed more than once at the direction of the Engineer, separate measurement will be made each time the area is mowed.

Corrective work will be compensated where seeding and mulching has been damaged or has failed to establish a satisfactory stand of vegetation.

Where correction can be made without extensive seedbed preparation, the work will be paid for in accordance with Section 1661 for *Seed for Repair Seeding* and *Fertilizer for Repair Seeding*.

Where earthwork and seeding and mulching has been damaged to the extent that earthwork repairs or complete reshaping are necessary, the Contractor will be paid at the contract unit price for the excavated material required for repairs to the damaged earthwork, and at the contract unit price for *Seeding and Mulching* for correcting the damaged seeding and mulching.

As an exception to the above, repair, at no cost to the Department, any damage to earthwork or seeded and mulched areas which is due to carelessness or neglect on the part of the Contractor.

Payment will be made under:

Pay Item	Pay Unit
Seeding and Mulching	Acre
Mowing	Acre

SECTION 1661
REPAIR SEEDING

1661-1 DESCRIPTION

Repair areas which have been previously seeded and mulched in accordance with Section 1660 but which have been damaged or have failed to successfully establish a stand of vegetation. This work does not include repair seeding made necessary by negligence on the part of the Contractor as described in Article 1660-7, nor does it include repairs to temporary seeding constructed in accordance with Section 1620.

Repair damage or failure in accordance with this section where correction can be made without extensive seedbed preparation.

Where correction will require extensive seedbed preparation, or where earthwork repairs or complete reshaping are necessary, repair in accordance with Section 1660.

Repair seeding includes minor seedbed preparation; the furnishing, placing, and covering of fertilizer and seed; and mulch as required, all in accordance with these Specifications.

Perform repair seeding promptly at the locations and times as directed.

The actual conditions which occur during the construction of the project will determine the quantity of seed or fertilizer used. The quantity of seed or fertilizer may be increased, decreased, or eliminated entirely at the discretion of the Engineer. Such variation in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1661-2 MATERIALS

Refer to Division 10

Item	Section
Fertilizer	1060-2
Seed	1060-4
Mulch for Erosion Control	1060-5

The analysis of fertilizer and the kinds of seed shall be as stated in the contract.

1661-3 SEEDBED PREPARATION

Seedbed preparation will be required unless otherwise permitted.

A seedbed preparation as extensive as that performed for the original seeding and mulching will not be required. The degree of preparation shall be sufficient to retain the seed against displacement by wind, rain, or surface runoff, and be acceptable to the Engineer. The acceptable degree of seedbed preparation will depend on the location, soil conditions, and drainage conditions at the site.

1661-4 APPLICATION OF FERTILIZER, SEED AND MULCH

The analysis of fertilizer, the kinds of seed, and the rates of application of seed and fertilizer is the same as specified in the project special provision for seeding and mulching, unless otherwise directed, but in no case will the total rate of seed and fertilizer vary more or less than 25 percent of that specified for seeding and mulching.

Do not distribute fertilizer or sow seed when the Engineer determines that conditions are unfavorable for such operations.

Cover fertilizer and seed and secure mulch in place to prevent displacement by wind, rain, or surface runoff.

The requirements of Article 1660-5 will be applicable to the approval of equipment; the use of liquid fertilizer; and the protection of traffic, structures, guardrails, traffic control devices, and other appurtenances.

1661-5 MEASUREMENT AND PAYMENT

Seed for repair seeding will be measured and paid for in pounds. The weight of seed will be determined by bag count of standard weight bags or by weighing the seed on certified platform scales or other certified weighing devices. No direct payment will be made for furnishing and applying mulch and all materials used to hold mulch in place, as

such work and materials will be considered to be incidental to the work covered by *Seed for Repair Seeding*.

Fertilizer for repair seeding will be measured and paid for in tons. The weight of dry fertilizer will be determined by bag count of standard weight bags, or by weighing the fertilizer in trucks on certified platform scales or other certified weighing devices. The weight of liquid fertilizer will be the equivalent weight in tons of dry fertilizer.

Payment will be made under:

Pay Item	Pay Unit
Seed for Repair Seeding	Pound
Fertilizer for Repair Seeding	Ton

SECTION 1662
SUPPLEMENTAL SEEDING

1662-1 DESCRIPTION

Apply additional seed to areas which have been previously seeded with permanent seed but on which there is an unsatisfactory cover of vegetation.

This work is only to provide an additional amount of seed to areas that have an insufficient stand of vegetation but which are too well established to require repair seeding. Work covered by this provision does NOT include seedbed preparation, fertilizer, or mulch.

Perform supplemental seeding promptly at the locations and times as directed.

The actual conditions which occur during the construction of the project will determine the quantity of seed used. The quantity of seed may be increased, decreased, or eliminated entirely as directed. Such variation in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1662-2 MATERIALS

Refer to Division 10

Item	Section
Seed	1060-4

Use the kinds of seeds as stated in the contract.

1662-3 APPLICATION

Seedbed preparation will not be required.

The contract will state the kinds and rates of application of seed. Sow no seed when the Engineer determines that conditions are unfavorable.

The requirements of Article 1660-5 will be applicable to the approval of equipment; and the protection of traffic, traffic control devices, and other appurtenances.

1662-4 MEASUREMENT AND PAYMENT

Seed for supplemental seeding will be measured and paid for in pounds. The weight of seed will be determined by bag count of standard weight bags or by weighing the seed on certified platform scales or other certified weighing devices.

Payment will be made under:

Pay Item	Pay Unit
Seed for Supplemental Seeding	Pound

SECTION 1664
SODDING

1664-1 DESCRIPTION

Prepare soil, furnish and place limestone, fertilizer, sod, and water; and other operations necessary for the permanent establishment of vegetation from sod on shoulders, slopes, ditches, or other roadside areas.

Adapt operations to variations in weather and soil conditions so as to assure the successful establishment and growth of grasses.

Preserve the required line, grade, and cross-section of the area treated.

The actual conditions which occur during the construction of the project will determine the quantity of water used and mowing required. The quantity of water or mowing may be increased, decreased or eliminated entirely at the direction of the Engineer. Such variations in quantity will not be considered alterations in the details of construction or a change in the character of the work.

1664-2 MATERIALS

Refer to Division 10

Item	Section
Fertilizer	1060-2
Limestone	1060-3
Sod	1060-7
Water	1060-9

The contract will state the analysis of fertilizer and the kinds of sod.

1664-3 SODDING

(A) Handling and Storing Sod

Exercise extreme care during all operations of loading, transporting, unloading, storing, placing, tamping, and staking sod, to prevent breaking the sod sections and to prevent the sod from drying out. Any sod that is torn, broken, or too dry will be rejected. Torn or broken sod, if kept moist, may be used for filling unavoidable small gaps in sod cover as permitted.

Place sod on the designated areas within 48 hours after being cut unless otherwise directed.

(B) Soil Preparation

Remove litter and other debris. Mow and satisfactorily dispose of weeds or other unacceptable growth on the areas to be sodded.

Bring the area to be sodded to a firm uniform surface at such elevation that the surface of the complete sodding conforms to the finished grade and cross section as shown on the plans.

Scarify or otherwise loosen soil to a depth of not less than 5 inches. Break clods and work the top 2 to 3 inches of soil into an acceptable soil bed by using soil pulverizers, drags, or harrows.

Place limestone and fertilizer prior to placing the sod. The contract will state the kind and grade of fertilizer, and the rates of application of limestone and fertilizer. Distribute the limestone and fertilizer uniformly over the area and thoroughly mix in the top five inches of the soil by discing, harrowing, or other approved methods.

Prepare the area by harrowing, dragging, raking, or other approved methods to give a lawn type finish. Remove all trash, debris and stones larger than 1-1/2 inch in diameter or other obstructions that could interfere with the placing of the sod. Moisten the finished surface with water prior to placing the sod.

(C) Placing Sod

The contract will state the seasonal limitations for sodding and the kind of sod to use.

Sod handling and placement will be a continuous process of cutting, transporting, and installing without appreciable delays. Install sod within 48 hours after being cut and water immediately after installation.

Place sod firmly and carefully by hand within 24 hours after soil preparation is completed and accepted by the Engineer. Pack each piece of sod tightly against the edge of adjacent pieces so that the fewest possible gaps will be left between the pieces. Close unavoidable gaps with small pieces of sod.

When placing sod on a slope, begin at either the top or the toe of the slope. Place sod with the long edge horizontal and with staggered vertical joints. Turn the edge of the sod slightly into the ground at the top of a slope and place a layer of earth over it and compact so as to divert the surface water over and onto the top of the sod.

Stake sod in place by driving stakes flush with the sod, on all slopes 2:1 or steeper, in drainage channels, on other areas shown on the plans, and on any areas that are in such condition that there is danger of sod slipping. Perform staking concurrently with sod placement and prior to tamping with sound wooden stakes which are approximately 1 inch square or 1 inch in diameter and not less than 12 inches in length. Place enough stakes to prevent slipping or displacement of the sod. Drive stakes perpendicular to the slope. Where backfill is necessary on cut slopes to obtain a uniform sodding area, provide stakes of sufficient length to reach a minimum of 3 inches into the solid earth underneath the backfill.

On all other areas, use metal staples in place of wooden stakes. The metal staples should be 12 inches long, made of 11 gauge new steel wire so as not to bend when pinned or driven through the sod. Shorter staples may be used with the approval of the Engineer.

Place, stake, and staple the sod where necessary, then tamp or roll carefully and firmly by acceptable means. If rolled, roller shall weigh 150#/ft of roller width. Take extreme care to prevent the installed sod from being torn or displaced.

Do not place sod when the atmospheric temperature is below 32°F. Do not use frozen sod or place on frozen soil.

(D) Watering Sod

Water carefully and thoroughly after sod has been placed and tamped. Perform watering as directed until final acceptance. Application of water may be made by the use of hydraulic seeding equipment, farm type irrigation equipment, or by other acceptable means.

1664-4 MAINTENANCE

Maintain sod in a satisfactory and live condition until final acceptance of the project. Maintenance includes watering and mowing at the locations and times as directed.

1664-5 MEASUREMENT AND PAYMENT

Sodding will be measured and paid for in square yards, measured along the surface of the ground that has been completed and accepted. No direct payment will be made for mowing the sodding areas prior to soil preparation as such work will be considered to be incidental to sodding. No direct payment will be made for furnishing and applying limestone and fertilizer, as such will be incidental to the work covered by sodding.

Water will be measured and paid for in 1,000 gallon units. Measurement of water will be made by means of an approved metering device at the source of supply, or by determining the volumetric capacity of tank trucks used to deliver water to the project and recording the number of loads delivered by each truck.

Mowing will be measured and paid for in accordance with Section 1660.

The above prices and payment will be full compensation for all work covered by this section.

Payment will be made under:

Pay Item	Pay Unit
Sodding	Square Yard
Water	1,000 Gallons

SECTION 1665
FERTILIZER TOPDRESSING

1665-1 DESCRIPTION

Furnish and uniformly distribute fertilizer as a topdressing to areas on which seeding and mulching, sprigging, or sodding are completed and a vegetative cover is established. Top dress previously seeded, sprigged, or sodded areas under other contracts when so stated in the contract or where so directed.

The actual conditions that occur during the construction of the project will determine the quantity of fertilizer topdressing used. In the event that a vegetative cover has not had sufficient time to develop to a size suitable for topdressing before completion of the project, the work of fertilizer topdressing will be decreased or eliminated entirely. Where the use of additional fertilizer topdressing would be beneficial to the establishment of grasses or legumes, the work of fertilizer topdressing will be increased. The quantity of fertilizer topdressing may be increased, decreased, or eliminated entirely as directed. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of work.

1665-2 MATERIALS

Use fertilizer containing no urea for topdressing.

Refer to Division 10:

Item	Section
Fertilizer	1060-2

The analysis of fertilizer shall be as stated in the contract.

1665-3 APPLICATION OF FERTILIZER TOPDRESSING

Apply fertilizer topdressing at the locations and times as directed, regardless of whether or not other seeding, sprigging, or sodding operations are underway at the time.

The contract will state the rate of application and analysis of fertilizer. Distribute fertilizer uniformly without any type of soil disturbance.

Refer to the requirements of the contract for the approval of equipment; the use of liquid fertilizer; and the protection of traffic, structures, guardrails, traffic control devices, and other appurtenances.

1665-4 MEASUREMENT AND PAYMENT

Fertilizer topdressing will be measured and be paid in tons. The weight of dry fertilizer will be determined by bag count of standard weight bags, or by weighing the fertilizer in trucks on certified platform scales or other certified weighing devices. The weight of liquid fertilizer will be the equivalent weight in tons of dry fertilizer.

In the event that an alternative analysis of fertilizer topdressing is approved and used, it will be in an equivalent number of tons of fertilizer, of the specified analysis, based on nutrient value.

Payment will be made under:

Pay Item	Pay Unit
Fertilizer Topdressing	Ton

SECTION 1670
PLANTING

1670-1 DESCRIPTION

Furnish, deliver, and plant trees, shrubs, vines, ground covers, bedding plants, and seedlings at locations shown on the plans or as directed, in accordance with these Specifications.

The work of planting includes plant bed preparation, initial planting, plant establishment, and replacement planting.

Perform the operations in a careful, workmanlike manner that will promote the continued life and healthy growth of all plants in their final location.

The actual conditions that occur during the construction of the project will determine the quantity of plant bed fumigation or post-emergence and pre-emergence herbicidal treatment for plant beds. The quantities of plant bed fumigation and post-emergence and pre-emergence herbicidal treatment for plant beds may be increased, decreased, or eliminated entirely as directed. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1670-2 MATERIALS

Refer to Division 10

Item	Section
Fertilizer	1060-2
Water	1060-9
Plant Materials – Nursery Grown	1060-10
Mulch for Planting	1060-11
Materials for Staking or Guying	1060-12
Herbicide	1060-13

Furnish nursery grown plant materials.

Use methyl bromide as fumigant consisting of a mixture of 80% methyl bromide and 20% chloropicrin. A different ratio of fumigant containing methyl bromide and chloropicrin may be used provided that the amount of active ingredient specified in Article 1670-7 is provided.

Use a 2 mil. polyethylene agricultural plastic sheeting free of holes, punctures, and tears to cover the fumigated plant beds. Use an appropriate width of plastic for the width of the plant bed, and obtain approval prior to fumigation.

The contract will state the kind of herbicides to be used.

1670-3 WEATHER AND SEASONAL LIMITATIONS

Perform planting operations only between the dates shown in the contract except where otherwise permitted in writing.

Do not plant when the temperature is below 32°F, when the plant hole is frozen or when soil to excavate and fill the plant hole is frozen, or too wet.

Perform fumigation during or within 2 weeks prior to the time allowed for planting as shown in the contract. Fumigate when the soil temperature is at least 55°F at a depth of 5 inches and moderately moist (50-85% of field capacity).

Apply post-emergence herbicide when the weeds are near maturity but not when the weeds are under stress from drought, disease, insect damage, or any other cause.

Do not apply post-emergence herbicide when rain is likely within the next 6 hours or as restricted on the product label.

1670-4 CARE AND HANDLING PLANTS

(A) General

Exercise utmost care in digging, loading, transporting, unloading, planting, or otherwise handling plants, and use adequate precautions to prevent injury to or drying out of the trunk, branches, or roots; and to prevent freezing of the plant roots. Heel-in plants within 48 hours of delivery from the nursery, if they can not be planted within that time.

Properly maintain all heeled-in plants until planted. Do not have plants remain heeled-in for more than 30 days. Open plants immediately when delivered in boxes or wrapped in bundles or other forms of closed packages and inspect and dampen if necessary.

(B) Balled and Burlapped Plants

Protect the roots of balled and burlapped plants, if not immediately planted after delivery, by adequately covering with a soil, mulch, or sawdust that is kept moist constantly in an acceptable manner appropriate to weather or seasonal conditions. Preserve the solidity of the plant ball carefully.

(C) Bare Rooted Plants

Refrigerate or immediately heel-in all plants, if not promptly planted, in moist soil, mulch, or sawdust in an acceptable manner corresponding to generally accepted horticultural practice.

Protect the plants from drying out by means of wet canvas, burlap, or straw, or by other means acceptable while being transported or planted.

1670-5 PLANT LOCATION

Locate and mark on the ground locations for plants and outlines for areas to be planted or reforested and obtain approval prior to digging plant holes for beds.

Where so directed, furnish and install standard identification wires with plastic flags to designate individual plants in major planting areas.

Flags will not necessarily be needed for all plants required by the contract, but use these flags on portions of the project until plant locations in these portions are approved.

Unforeseen conditions may make it necessary to make minor adjustments in plant locations due to utility lines, traffic signs, rock, drainage, etc., and such adjustments will be permitted subject to approval.

1670-6 PRUNING

Prune shrubs and trees after planting as shown on the plans or as directed by the Engineer. Pruning done at any time in no way alters the Department's right to reject plant material. Prune in accordance with the International Society of Arboriculture pruning techniques, and according to shape, size, and condition of the individual plant.

1670-7 PLANT BED TREATMENT

(A) General:

Treat plant beds by fumigation or by application of herbicides where called for by the plans or directed.

(B) License

Make pesticide applications by or under the direct supervision of an applicator licensed by the North Carolina Department of Agriculture and Consumer Services.

(C) Fumigation

Fumigate the plant beds with an approved fumigant in preparation for planting.

Prior to fumigation, level the plant bed to a proper planting grade. Till the bed to a depth of 5 to 8 inches. Prepare soil in good tilth with no dry clods over 1 inch in diameter present. Cover with plastic tarp within 24 hours of soil preparation completion or other approved process.

Apply the approved fumigant gas according to product labeling. If plastic is required then Use envelope folds at the edges of the bed with the edge of the plastic buried 4 to 6 inches deep.

Keep the plastic over the bed for a period of 48 to 72 hours. Reform the bed to the required shape, after removal of the plastic, with little or no soil inversion. Pursue continuous planting within 24 hours of plastic cover removal.

(D) Post-Emergence Herbicidal Treatment

Post-emergence herbicidal treatment includes applications of a systemic post-emergence total vegetation control herbicide.

The contract will state the rates of application of the post-emergence herbicides.

Apply all herbicides in accordance with the manufacturer's instructions on the product label.

Apply post-emergence herbicide when the weeds are near maturity but not when the weeds are under stress from drought, disease, insect damage, or any other cause. If cloudy weather or other poor growing conditions are present, extend this 7 day period until there are visible signs of herbicidal activity. Reapply if necessary to achieve a thorough control.

Post-Emergence Application for Plant Bed Preparation:

Apply a systemic post-emergence total vegetation control herbicide to the bed area before any tilling or mowing is performed. Perform no tilling or mowing for at least 7 days after the application. Thoroughly till the bed after the waiting period, or when injury to the vegetation appears. Prepare the soil in good tilth with no clods over 1 inch present and prior to planting.

Post-Emergence Application for Plant Bed Maintenance:

Apply a systemic post-emergence herbicidal treatment in accordance with product label in a manner to ensure no damage to planted material. Perform no mowing or vegetation removal by other means for at least 7 days after the application.

(E) Pre-Emergence Herbicidal Treatment

Pre-emergence herbicidal treatment includes the application of a pre-emergence herbicide.

Apply a pre-emergence herbicide to the plant bed after the existing vegetation has been completely controlled by a post-emergence herbicide application as specified in Subarticle 1670-7 (D) and after installation of planting and mulching as described in Article 1670-9 and Article 1670-10. Apply pre-emergence herbicide following planting and mulching of plant bed prior to germination of weed seeds. An additional application of post-emergence herbicidal treatment may be necessary to control emerged weeds, as directed, if sufficient time has lapsed between tillage and installation of plant material and mulch. No direct payment will be made for additional post-emergence herbicidal work if such work is due to carelessness or neglect on the part of the Contractor.

Apply herbicide evenly over the soil surface with properly calibrated equipment at the specified rate.

If a minimum of 0.5 inch of rainfall does not occur within 15 days of application of pre-emergence herbicidal treatment, apply a minimum of 0.5 inch of water (2.8 gallons per square yard uniformly over the planting area to activate the herbicide.

1670-8 EXCAVATION OF PLANT HOLES

Provide cylindrical shaped plant hole excavations for plants other than reforestation plants, with the plant location stake marking the center of the circle and with the sides of the hole being approximately vertical. When mechanical means are used which make digging

of cylindrical holes impractical, the complete hole shall have the minimum dimensions as shown on the plans.

When plants are to be grouped together in a plant bed as contrasted to widely separated individual plants, and when so indicated on the plans, loosen and pulverize clods to a depth of not less than 5 inches for the entire area of the plant bed by means of a scarifier, disc, spade, or other appropriate means before plant holes are dug.

Plant reforestation plants in holes made by a planting spade, planting bar, or other means which meet the approval of the Engineer. Make the hole of sufficient size to accommodate the entire extended root system of the plant without cramping.

1670-9 PLANTING, BACKFILLING, AND WATERING

(A) General

The plans will state the kind and rate of application of fertilizer. Apply fertilizer during backfilling operations in a manner that will ensure proper placement of the fertilizer and avoid injury to the roots.

Scarify the walls and floor of the plant hole after the plant hole is dug. Place the plant in the prepared plant hole at the proper position as regards to depth, alignment, final grade of the surrounding ground level, and vertical placement of the trunk. Maintain this position during all subsequent backfilling and watering operations. Set plants with the root collar at the same depth as grown in the nursery or raise above grade as indicated on the plans.

Moisten the soil with water after one-half to two-thirds of the backfilling and tamping has been completed, if the soil in the plant holes is not sufficiently moist. Apply water to moisten all soil but not a quantity that will saturate the soil to the extent of excluding all air from around the roots. Place the remainder of the backfill after complete absorption of water.

Construct water rings around all plants, except reforestation plants, in accordance with details shown on the plans. A water ring consists of a ridge of firmed soil in a ring around the plant and of a minimum inside diameter equal to the diameter of the plant hole. This ridge is approximately 6 inches high and is compacted firmly enough to hold water.

(B) Balled and Burlapped Plants

Handle balled and burlapped plants by the ball and place in the plant hole so that the soil of the ball will not be loosened from the roots. After the hole has been almost completely backfilled and the soil thoroughly firmed under and around the ball, cut the burlap away and remove from around the stem of the plant. Complete backfilling so as to avoid loosening of the soil of the root ball.

(C) Container Grown Plants

Planting requirements for container grown plants are the same as applicable to balled and burlapped plants. Remove container immediately before planting. During the removal of the container sufficient precautions shall be taken so as to ensure that the soil and roots inside the container are undisturbed. Scarify roots when directed.

(D) Bare Rooted Plants

Before the plant is placed in the plant hole, cut off smoothly any bruised or broken parts of roots. Place the plant in its proper position in the hole and backfill. Carefully place the backfill material, worked around and under the roots, and compacted in a manner that avoids bruising or breaking the roots.

(E) Reforestation Plants

Reforestation includes tree reforestation and shrub reforestation. Type, mixture, size, furnish description, and spacing will be as shown on the reforestation detail sheet in the plans.

Prior to beginning reforestation, each area to be reforested will be measured by the Engineer to determine the exact number of acres for tree reforestation or square yards or shrub reforestation therein, and the quantity of each species of seedling to be planted within the area.

Where structures or plantings do not adequately delineate the outline of the area to be reforested, stake the outline of the area as directed by the Engineer. Furnish cypress, cedar, oak, locust, or other wood stakes approved by the Engineer. Provide stakes with a minimum industry standard of 2" x 2" (nominal) size and approximately 30 inches in length with a 15 inch white top. Drive stakes in the ground with approximately 18 inches remaining above the ground line, and place as necessary to define and delineate the reforestation outline.

Have sample stock of reforestation seedlings inspected by the Engineer, for general health and moisture content, within 24 hours prior to planting.

After the plant hole has been prepared, place the plant upright in the hole at the correct depth without crowding or bunching the roots. Firm the soil around the root system from the bottom of the plant hole to natural ground elevation.

Upon completion of planting the required number of seedlings within all areas to be reforested, the Contractor will be relieved of further responsibility in connection with reforestation except for damage caused directly by the Contractor.

1670-10 MULCH FOR PLANTING

Place mulch within 7 days of initial planting as a top layer on the backfilled plant hole and water ring. Place mulch approximately 4 inches deep as shown on the plans or as directed. Place additional mulch as directed during establishment.

No mulching will be required for reforestation plants.

1670-11 WATER FOR PLANTING

Water at the time of planting as specified in Article 1670-9 and at the Contractor's election and the Engineer's approval. Water with gravity flow or low pressure applicators which have been approved, and which will not erode soil around the plant root system or damage to plants. Saturate the soil around each plant thoroughly at each watering.

1670-12 STAKING OR GUYING

Stake or guy plants as shown on the plans or as directed to prevent damage.

Ensure that the plant is attached and held rigid to the support in a manner that will prevent chafing or other injury to the bark, and that will permit normal development of the trunk or branch.

1670-13 INITIAL PLANTING

Initial planting will be considered complete when the plants have been placed in the plant hole, backfilled, fertilized, watered, mulched, staked, and guyed, and the plants are in an acceptable condition.

1670-14 ESTABLISHMENT

Begin establishment for all initial or replacement plants immediately after they are planted. Maintain trees, shrubs, vines, and groundcovers, and the area of planting until final acceptance of the project. Mow and maintain the area around trees and shrubs for a distance of 6 feet beyond the outside limits of water rings or 6 feet beyond the limits of the guy stakes, whichever is greater; within shrub beds; and for a distance of 6 feet outside the perimeter of the shrub beds. Establishment includes cutting of grass and control of weeds; watering; fertilization; replacement of mulch; repair or replacement of guy stakes, guy wires, and water rings; and other work as directed to ensure the survival and growth of plant material and the satisfactory appearance of the project. Remove dead plant material from the project during the establishment period.

1670-15 REPLACEMENT PLANTING

Replacement planting of trees, shrubs, and ground cover consists of replacing those plants which are not in a living, healthy condition or do not conform to the Specifications contained in the edition of *American Standard for Nursery Stock* or that have been damaged or stolen. Replacement of reforestation plants will not be required.

Perform replacement planting within the planting season specified in the contract.

1670-16 FINAL INSPECTION

All planting shall be completed and all plants shall be in a living and healthy condition at the time of final inspection.

1670-17 MEASUREMENT AND PAYMENT

(Plant species and size indicated in contract) will be measured and paid for in units of each, other than reforestation plants, that have been planted and accepted.

Reforestation will be measured and paid for in acres of land measured along the surface of the ground.

Wetland reforestation will be measured and paid for in acres of land, measured along the surface of the ground.

Plant bed fumigation will be measured and paid for in square yards of plant bed measured along the surface of the ground.

Post-emergence herbicidal treatment will be measured and paid for in square yards of plant bed measured along the surface of the ground.

Pre-emergence herbicidal treatment will be measured and paid for in square yards of plant bed measured along the surface of the ground.

Mulch for planting will be measured and paid for in cubic yards. Where mulch is furnished in bales or bags, the number of cubic yards in each bale or bag will be determined and then multiplied by the number of bales or bags of the same size which have been acceptably furnished and placed. Where mulch is furnished in trucks, each truck will be measured by the Engineer and shall bear a legible identification mark indicating its capacity. Load each truck to at least its measured capacity at the time it arrives at the site of the work.

Water for planting will be measured and paid for in units of 1,000 gallon units. Measurement of water will be made by means of an approved metering device at the source of supply, or by determining the volumetric capacity of tank trucks used to deliver water to the project and recording the number of loads delivered by each truck.

No payment will be made for plant bed preparation, tillage, staking or guying, and fertilization, for this work will be considered incidental to other work in the contract.

Payment will be made under:

Pay Item	**Pay Unit**
(Plant species and size indicated in contract)	Each
Reforestation	Acre
Wetland Reforestation	Acre
Plant Bed Fumigation	Square Yard
Post-Emergence Herbicidal Treatment for Plant Beds	Square Yard
Pre-Emergence Herbicidal Treatment for Plant Beds	Square Yard
Mulch for Planting	Cubic Yard
Water for Planting	1000 Gallons

DIVISION 17
SIGNALS AND INTELLIGENT TRANSPORTATION SYSTEMS

SECTION 1700
GENERAL REQUIREMENTS

1700-1 DESCRIPTION

Furnish, install, modify, and remove signals, flashing beacons, intelligent transportation systems, electrical systems, and provisions for future systems.

1700-2 MATERIAL

Refer to Article 1098-1 General Requirements.

1700-3 CONSTRUCTION METHODS

(A) General

Before beginning signal work, verify all existing signal equipment is in satisfactory working order. Report all defective signal equipment to the Engineer so as not to be held responsible for defects.

Locate existing conduit, cable runs, inductive detection loops, lead-in, junction boxes, and detection equipment before installing or using equipment that can damage or interfere with such facilities. The locations of existing inductive detection loops shown are approximate.

Locate all underground utilities before beginning drilling, digging, or trenching operations.

Immediately cease work and notify the Engineer and affected owners if damage to existing utilities, cables, or equipment occurs. Make all required repairs and replacements at no additional cost to the Department.

(B) Regulations and Codes

Furnish material and workmanship conforming to the NEC, NESC, UL, and all local safety codes in effect on the date of advertisement. Comply with Article 4, Chapter 87 of the *North Carolina General Statutes* (Licensing of Electrical Contractors). Comply with all regulations and codes imposed by the owner of affected utility poles. In the event of a conflict between the NEC, NESC, UL, local safety codes and these Specifications, the cited documents will govern.

Where required, conform to ITE, AASHTO, and ASTM in effect on the date of advertisement.

Notify the Engineer, local traffic enforcement agency, local utility company, and affected railroad companies seven business days before operational shutdowns to coordinate connection or disconnection to an existing utility or system.

Install standoffs, meter bases, and service disconnects as required by the NESC, NEC, local utility companies, and local ordinances.

(C) Utility Services

Coordinate all work to ensure electrical power of proper voltage, phase, frequency, and ampacity is available to complete the work. Use electrical services cables with THW insulation.

When electrical, telephone, and telecommunication service is not furnished by the Department and is required, contact the utility company and make application to ensure all work can be completed. Obtain authorization for service in the Department's name and make application for service in the Department's name.

The Department will be responsible for direct payment of monthly utility company usage charges. The Contractor will be responsible for all expenses associated with utility installation costs, hookups, etc.

(D) Maintenance and Repair of Material

Furnish the Engineer with the name, office telephone number, cellular (mobile) telephone number, and pager number of the supervisory employee who will be responsible for maintenance and repair of equipment during all hours.

Maintain and repair all signal and communications related equipment within the project construction limits until completion of the observation period and receipt of written notification of final acceptance of the project.

For all failures, malfunctions, or damages to equipment, begin necessary repairs within four hours of notification. Complete repairs within eight hours of notification. Comply with Section 150 for maintenance of traffic flow. The inability to contact the supervisory employee or prearranged alternate will not extend repair time requirements.

Remove and replace all signal and communications related equipment that fails. The Department will furnish the Contractor replacement equipment for Department-furnished equipment that fails.

Except for damages and malfunctions caused by the Contractor's work activities, the Contractor will not be held responsible for pre-existing conditions reported to the Engineer before starting traffic signal work at the specific intersection. The Contractor will assume responsibility for all maintenance and emergency services necessary once traffic signal work has begun at the specific intersection and for all damages and malfunctions caused either directly or indirectly by the Contractor's work activities.

In the event the Contractor fails to perform in accordance with the plans and Specifications within the time frame specified, the Department reserves the right to perform maintenance and emergency service necessary to ensure continuous traffic signal operation. Further, all expenses incurred by the Department in implementing this option will be deducted from payment due the Contractor, plus $2,500 liquidated damage per occasion, per day, or any portion thereof, until corrected.

(E) Inspections

The Department may access the Contractor's equipment to perform railroad, signal, and preventative maintenance inspections, or conflict monitor certification as necessary. The Contractor shall be present for these inspections.

(F) Removal of Existing Equipment and Material

Remove all Department-owned signals and communications related equipment and material that will not be used. Assume ownership of removed poles, messenger cable, interconnect cable, communications cable, and supporting hardware. Return all other equipment and material between 8:00 a.m. and 12:00 p.m., Monday through Thursday, to the Traffic Services Office within the Division responsible for administration of the project.

The Department will deduct the cost of Department-owned equipment damaged by the Contractor from money due to the Contractor.

(G) Railroad Preemption

Where railroad preemption is required, coordinate all work with the railroad company. Do not place signals into operation until signal equipment has been interconnected with required railroad-highway crossing devices and railroad preemption is working properly. Ensure preemption sequences begin immediately after activation of train detection.

Contact and coordinate with the railroad company to schedule interconnection of the signal to the railroad controller cabinet. Install lead-in cable from the signal controller cabinet to a railroad company furnished and installed lockable junction box. Interconnection will be made by the railroad company.

Provide fail-safe operation such that removal of voltage from the railroad side of the isolation relay will initiate the railroad preemption sequence.

(H) Vehicle Preemption Systems

Where required, implement and install vehicle preemption systems. Coordinate vehicle preemption work with the proper operating authority. Contact the proper operating authority and schedule installation of preemption equipment.

(I) Timing of Signals

Implement timing values for signal controllers. Modify proposed phasing and timing of existing controllers

Reinstall all existing time-based coordination. As directed, make modifications to existing coordination to account for changes in signal phasing.

The Department reserves the right to make, or have the Contractor make, field timing changes necessary for pattern optimization and to eliminate identifiable, potential hazards to the motoring public. The Engineer will notify the Contractor of timing changes made.

(J) Wire and Cable

For installation in a conduit system, lubricate cable and wires before installing in conduit. Use lubricant that will not physically or chemically harm cable jacket, wire insulation, and conduit.

Splice all electrical wire and cable at recessed-screw, barrier type terminal blocks, in junction boxes, or in condulets. Unless specifically allowed, connect no more than two conductors to the same terminal screw.

Maintain color coding of wires through splices.

Protect ends of wire and cable from water and moisture.

Install all wire and cable with necessary hardware including, but not limited to shoulder eyebolts, washers, nuts, thimbleyelets, three-bolt clamps, J-hooks, split bolt connectors, grounding clamps, and lashing material.

(K) Grounding

Provide a grounding system at all new and revised electrical service points unless otherwise specified.

In addition to NEC requirements, test grounding electrode resistance at connection point to electrical service ground bus for a maximum of 20 ohms. Furnish and install additional ground rods to grounding electrode system as necessary to meet test requirements. Submit a completed Inductive Detection Loop & Grounding Test Results form. The form is located on the Department's website.

Provide a length of marker tape 6 to 12 inches below finished grade directly over grounding electrodes and conductors.

(L) Electrical Bonding

Using an approved termination means, connect a number 14 AWG minimum 19-strand copper conductor (Type THW) with green insulation to serve as an equipment grounding conductor to metal poles, vehicular and pedestrian signal pedestals, and other metallic components which are not otherwise bonded through means approved by the Engineer.

(M) Traffic Signal Activation

Do not place signal in steady (stop-and-go) mode until inspected and authorized by the Engineer.

(N) Temporary Traffic Signal Installations

When a traffic signal is installed for control of traffic during construction of the project and scheduled for removal during or upon completion of the project, install and remove the temporary traffic signal as required. Upon removal of the temporary traffic signal, restore surface to like-new condition. Rake smooth unpaved areas, repave paved areas, and seed grassed areas that were damaged by Contractor activities.

Prepare intersection for sign control before removing the temporary traffic signal. Install required regulatory signs in accordance with Sections 900, 901, and 903. Cover signs with burlap bags until traffic signal is placed into flashing operation.

Place traffic signal into flashing operation and uncover signs simultaneously. Allow flashing operation for a minimum of seven consecutive days before removal.

Signal cabinets, controllers, detector units, signal heads and accessories, and microwave detectors are property of the Department. Return Department owned equipment between 8:00 a.m. and 12:00 p.m., Monday through Thursday, to the Traffic Services Office within the Division responsible for administration of the project. Assume ownership of removed poles, messenger cable; interconnect cable, communications cable, supporting hardware, and loop emulator detection equipment, unless otherwise specified.

The Department will deduct the cost of Department-owned equipment damaged by the Contractor from money due to the Contractor.

1700-4 MEASUREMENT AND PAYMENT

There will be no direct payment for work covered in this section. Payment at the contract unit prices for the various items in the contract will be full compensation for all work covered by this section.

SECTION 1705
SIGNAL HEADS

1705-1 DESCRIPTION

Furnish and install vehicle and pedestrian LED signal heads, visors, interconnecting brackets, wire entrance fittings, mounting assemblies, signal cable, lashing wire, pedestrian push buttons, pedestrian signal signs, grounding systems and all necessary hardware.

1705-2 MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL. Refer to the project special provisions.

1705-3 CONSTRUCTION METHODS

(A) General

Bag new pedestrian and vehicle signal heads with burlap bags or bags made of non-ripping material specifically designed for covering signal heads until signal heads are placed in operation. Do not use trash bags of any type.

When new signal heads are placed into operation, immediately bag and remove signals heads that are not to be reused.

Adjust each signal head vertically and horizontally so that light output will be of maximum effectiveness for traffic and pedestrians. Do not tilt signal heads forward.

Reposition signal heads as required for various construction phases.

(B) Vehicle Signal Heads

Install vehicle signal heads at the heights required in the *North Carolina Supplement to the MUTCD* in effect on the date of advertisement.

Where vehicle signal heads are installed on messenger cable, install mounting hardware consisting of messenger cable hanger, balance adjuster, bottom cap, wire entrance fitting bracket, and insulating bushings.

Where vehicle signal heads are installed on mast arms, install mounting hardware consisting of rigid vehicle signal head mounting brackets.

Install signal cable in continuous lengths between signal controller cabinets and signal heads. Route signal cable to minimize the length of cable installed, and the number of cables and conductors in each run. Pull 36 inches of additional signal cable into controller cabinets.

Wrap signal cable to messenger cable with at least four turns of wrapping tape spaced at intervals less than 15 inches or lash signal cable to messenger cable with one 360 degree spiral of lashing wire per 12 inches.

Make electrical connections inside each signal head, signal controller cabinet, and termination compartment in metal poles. Do not splice cable at any other point between signal heads and controller cabinet.

Coil sufficient signal cable beside each vehicle signal head to accommodate head shifts during various construction phases. For final signal head locations, coil 36 inches on each side of signal head if signal cable comes from both directions. If signal cable terminates at the signal head, coil 36 inches of signal cable on the same side as the cable run.

(C) Pedestrian Signal Heads

Install signs with mounting hardware immediately above pedestrian push buttons.

Connect pushbutton to controller cabinet using lead-in cable. Bond pushbutton housing and all metal components to cabinet ground using cable ground.

1705-4 MEASUREMENT AND PAYMENT

Vehicle signal head (_____) and *Pedestrian signal head (___)* will be measured and paid for as the actual number of signal heads of each type, size, and number of sections furnished, installed, and accepted.

No measurement will be made of visors, wire entrance fittings, interconnecting brackets, mounting assemblies, pedestrian push buttons, and pedestrian signal signs as these will be considered incidental to furnishing and installing signal heads.

Signal cable will be measured and paid for as actual linear feet of signal cable furnished, installed, and accepted. Measurement will be point to point with no allowance for sag. Twenty-five feet will be allowed for vertical segments up or down poles.

No measurement will be made for drip loops, coiled sections, or lashing wire as these will be considered incidental to furnishing and installing signal cable.

Payment will be made under:

Pay Item	Pay Unit
Vehicle Signal Head (_____)	Each
Pedestrian Signal Head (_____)	Each
Signal Cable	Linear Foot

SECTION 1706
BACKPLATES

1706-1 DESCRIPTION

Furnish and install backplates for vehicle signal heads with all necessary hardware.

1706-2 MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Refer to Article 1098-2 Backplates.

1706-3 CONSTRUCTION METHODS

Install backplates for vehicle signal heads so as not to interfere with the function of all door hinges, signal section latches, and mounting hardware. Do not bend or deform backplates during installation. Gooseneck fittings may be installed in reverse to accommodate backplates. Use stainless steel fasteners for attaching backplates to signal sections.

1706-4 MEASUREMENT AND PAYMENT

Backplates will be measured and paid for in units of each, furnished, installed, and accepted. No measurement will be made for different sizes of backplates.

Payment will be made under:

Pay Item	Pay Unit
Backplate	Each

SECTION 1710
MESSENGER CABLE

1710-1 DESCRIPTION

Furnish and install messenger cable (spanwire) with cable clamps, machine bolts, eyebolts, 3-bolt clamps, eye nuts, split-bolt connectors, and all necessary hardware.

1710-2 MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Refer to Article 1098-3 Messenger Cable.

1710-3 CONSTRUCTION METHODS

Install guy assemblies before installing messenger cable.

Use 3/8-inch messenger cable for spans supporting vehicle signal heads, and/or signs.

Use 1/4-inch messenger cable for spans supporting only cables unless otherwise specified.

For messenger cable crossing over railroad tracks, provide a minimum of 27 feet of vertical clearance, unless otherwise specified.

For permanent installations, install messenger cable in continuous lengths with no splices except where an insulator is required. With prior approval, existing messenger for temporary installations may be extended instead of installing new messenger cable.

Tension messenger cable to eliminate appreciable sag and to match sag of surrounding utilities. Otherwise, allow 3 to 4 percent sag of the span length between poles.

Provide three-bolt clamp assemblies consisting of 5/8-inch diameter machine bolts, J-hooks, washers, and square nuts to attach messenger cable to wood poles. Provide machine bolts that are 3 inches longer than the pole diameter.

Attach messenger cable to poles using three bolt cable clamps with J-hooks in mid-runs and deadend strandvises at termination poles.

Maintain electrical continuity at all splices.

Messenger Cable for Signal Heads or Loop Lead-In Cable: For messenger cable attached to joint use poles, install a new grounding system that complies with Article 1720-3 for bonding messenger cable. If a pole ground exists on the joint use pole, bond new pole grounding system to existing pole ground using number 6 AWG minimum solid bare copper grounding wire terminated with split bolt connectors or Burndy clamps (UCG25RS) at each end.

Messenger Cable for Communications Cable: For messenger cable attached to joint use poles, bond messenger cable to existing pole ground using Burndy clamps (UCG25RS) at ends and at 1300-foot intervals. If existing poles do not have a grounding system, install new grounding system that complies with Article 1720-3 for bonding messenger cable.

On multiple messenger cable arrangements, connect all messenger cable ends with number 6 AWG minimum solid bare copper wire and bond with split bolt connectors or Burndy clamps (UCG25RS) or equivalent and terminate to pole ground.

1710-4 MEASUREMENT AND PAYMENT

Messenger cable (_____) will be measured and paid for as actual horizontal linear feet of messenger cable furnished, installed, and accepted. Measurement will be point to point with no allowance for sag.

No measurement will be made of cable clamps, machine bolts, eyebolts, three-bolt assemblies, eye nuts, split bolt connectors, and pole grounding systems as these will be considered incidental to furnishing and installing messenger cable.

Payment will be made under:

Pay Item	Pay Unit
Messenger Cable (_____)	Linear Foot

SECTION 1715
UNDERGROUND CONDUIT

1715-1 DESCRIPTION

Furnish and install conduit for underground installation with tracer wire, miscellaneous fittings, all necessary hardware, marker tape, backfill, graded stone, paving materials, and seeding and mulching.

1715-2 MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Refer to the following articles:

Item	Section
Conduit	1098-4
Backfill	1018-2
Graded Stone	545-2 and 545-3

1715-3 CONSTRUCTION METHODS

(A) General

Ensure conduit is free of moisture and debris before pulling cables.

Following installation of conduit where cable is not immediately installed, or conduit is for future use (spare), seal the ends of the conduit with a duct plug. Secure a pull line to the duct plug in such a manner that it will not interfere with installation of the duct plug and provides a watertight seal.

Extend ends of conduit 2 to 4 inches above concrete surfaces and 4 inches above crushed stone bases. For metallic conduit, install metallic bushings and bond conduits.

(1) Conduit Entering Junction Boxes

Terminate conduits installed for communications cables in oversized junction boxes. Do not install other conduits in the oversized junction box unless otherwise specified.

Terminate conduits installed for signal wiring, including loop lead-in cable, in standard size junction boxes unless otherwise specified.

For all conduits entering junction boxes, seal spare conduits with approved duct plugs. Seal conduits containing fiber-optic communications cable with mechanical sealing devices. Seal conduits containing signal cable and loop lead-in wire with moldable duct seal.

(2) Tracer Wire

Install tracer wire in all conduits containing fiber-optic cable. Pull tracer wire simultaneously in a continuous length with the fiber-optic cable. Where multiple pulls of fiber-optic cable are required and conduit is placed in the same trench, only one tracer wire is required. Where multiple pulls of fiber-optic cable are required and conduits may separate into individual trenches, install a tracer wire in each conduit run. Provide waterproof butt splices where tracer wire is spliced. Splicing is allowed only in cabinets and junction boxes. Label all tracer wires entering the equipment cabinet.

(3) Plan of Record Drawings

Upon completion of the conduit system for communications, furnish the Engineer with a plan of record drawing detailing the locations of the conduit system.

(B) Trenching

In certain cases the Contractor may use an alternate material and method of installation between trenching and plowing based on existing field conduits and preferences. Obtain approval before proceeding.

(1) General

Install PVC, HDPE, or rigid metallic conduit for all underground runs. Install metallic conduit at all locations where conduits cross beneath railroad tracks. Clean existing underground conduit to be incorporated into a new system. Bond all metallic conduit.

If more than one conduit is required between the same points, install conduit in one common trench. Install non-detectable marker tape.

Install longitudinal runs of conduit a minimum of 1 foot from back of curb or 6 feet from edge of pavement in the absence of curb.

Upon completion, restore surface to like-original condition within seven calendar days of occurrence of damage. Remove all rock and debris from backfill material. Remove excess material from site and compact area according to Article 300-7. Backfill with excavated material and compact to 95% of original density.

Backfill trench at locations along the trench path where non-movable objects, such as rocks and boulders, cannot be avoided. The purpose of the backfill is to provide a gradual change in elevation of the trench, so that excessive bending and stress will not be transferred to conduits once underground conduit system is installed.

After installation of conduits and upon completion of tamping and backfilling, perform a mandrel test on each conduit to ensure no conduit has been damaged. Furnish a non-metallic mandrel having a diameter of approximately 50% of the inside diameter of the conduit in which it is to be pulled through. If damage has occurred, replace the entire length of conduit. Ensure pull line is re-installed.

(2) Unpaved Trenching

Install conduit in all unpaved areas. Rake smooth the top 1 1/2 inches seed with same type of grass as surrounding area. Finish unpaved areas flush with surrounding natural ground.

(3) Paved Trenching

On concrete surfaces, replace the entire joint of concrete unless otherwise specified. On all other surfaces, neatly cut and replace the width of trench with like material.

Finish paved areas with materials matching damaged areas. For conduit installed under roadways, cut neatly and replace the width of paved area damaged by trenching. For conduit installed under sidewalks and walkways, remove entire section of slab from joint to joint and replace. Place graded stone material to temporarily maintain traffic where repairs cannot be performed immediately. Comply with Article 545-4.

(C) Plowing (HDPE Conduit Only)

Direct plow HDPE ducts simultaneously using chute plow method. Direct plow ducts at a minimum depth so the top of the highest duct is 30 inches deep unless otherwise approved.

Provide sufficient personnel to feed chute, operate prime mover and equipment carrying reels (if separate equipment is used), observe chute feeding, observe plowing, and observe reel payout. Use chute with adequate dimensions to allow for passage of duct without damage. During plow operation, continuously check chute opening and path to be sure there are no obstructions and monitor payout reels to be sure reels are turning at a steady rate.

With prior approval, install a junction box at locations where splicing or coupling of the underground polyethylene conduits is necessary. Otherwise, splicing or joining of underground polyethylene conduit is prohibited.

(D) Directional Drilling

(1) Pre-Approvals and Minimum Depth Requirements

Obtain approval before beginning drilling operations.

At all points where HDPE conduit will traverse under roadways, driveways, sidewalks, or Controlled Access Areas including entrance/exit ramps, maintain a minimum depth of 4 feet or 8 times the back reamer's diameter, whichever is deeper. For an installation that runs parallel to a controlled access area or entrance/exit ramps maintain a minimum depth of 30 inches below finished grade. Maintain a minimum clearance of 30 inches below finished grade when crossing ditch lines. For the following structures, the minimum clearance requirements are:

Man-made Structure	**Minimum Clearance Requirement**
Bridge foundation	5' horizontal & 4' vertical (clearances greater than minimum horizontal should continue to use the 4V:5H ratio, i.e., 10' horizontal should be no deeper than 8')
Drainage pipes less than 60"	1' above or below [while maintaining a minimum depth of 30" below grade]
Drainage pipes greater than 60"	1' above or 4' below [while maintaining a minimum depth of 30" below grade]
Box Culverts	1' above or 4' below [while maintaining a minimum depth of 30" below grade]
Slope protection	2' below
Slope protection foundation footing	5' below

Guarantee the drill rig operator and digital walkover locating system operator are factory-trained to operate the make and model of equipment provided and have a minimum of one year experience operating the make and model of drill rig. Submit documentation of the operators' training and experience for review at least two weeks before start of directional drilling operations.

Provide a means of collecting and containing drilling fluid/slurry that returns to the surface such as a slurry pit. Provide measures to prevent drilling fluids from entering drainage ditches and storm sewer systems. Prevent drilling fluid/slurry from accumulating on or flowing onto pedestrian walkways, driveways, and streets. Immediately remove all drilling fluids/slurry that are accidentally spilled.

(2) Directional Drill Operations

Provide grounding for the drill rig in accordance with the manufacturer's recommendations.

Place excavated material near the top of the working pit and dispose of properly. Backfill pits and trenches to facilitate drilling operations immediately after drilling is completed.

Use drill head suitable for type of material being drilled and sized no more than 2 inches larger than the outer diameter of the conduit. Direct drill to obtain proper depth and desired destination. Pressure grout with an approved bentonite/polymer slurry mixture to fill all voids. Do not jet alone or wet bore with water.

During drilling operation, locate drill head every 10 feet along drill path and before traversing underground utilities or structures. Use digital walkover

locating system to track drill head during directional drilling operation. Ensure locating system is capable of determining pitch, roll, heading, depth, and horizontal position of the drill head at any point.

Once drill head has reached final location, remove head, and install back reamer of appropriate size (no more than 2 inches larger than outer diameter of conduits) to simultaneously facilitate back reaming of drill hole and installation of conduit. Back reamer is sized larger than actual conduits to ensure conduits are not adversely subjected to deviations caused by the original drill operation and are as straight as practical in their final position.

The intent of these Specifications is to limit the diameter of the actual drill shaft/hole so that it is no more than 2 inches larger than the conduit outer diameter. The 2-inch larger diameter may be accomplished during the original bore or during the back reaming/conduit installation process.

Once installation of conduit has started, continue installation without interruption so as to prevent conduit from becoming firmly set. Apply bentonite/polymer slurry mixture during conduit installation.

Upon completion of conduit installation, perform a mandrel test on conduit system to ensure conduit has not been damaged. Furnish non-metallic mandrel with a diameter of approximately 50% of the inside diameter of the conduit in which it is to be pulled through. If damage has occurred, replace the entire length of conduit and ensure that pull line is re-installed.

(3) Drilling Fluids

Use lubrication for subsequent removal of material and immediate installation of the conduit. The use of water and other fluids in connection with directional drilling operations will be permitted only to the extent necessary to lubricate cuttings. Do not jet alone or wet bore with water. Use drilling fluid/slurry consisting of at least 10 percent high-grade bentonite/polymer slurry to consolidate excavated material and seal drill hole walls.

Transport waste drilling fluid/slurry from site and dispose of in a method that complies with local, state and federal laws and regulations.

(4) Conduit Splicing

With prior approval, install a junction box at locations where splicing or coupling of conduit is necessary. Otherwise, splicing or joining of HDPE conduit is prohibited.

(E) Bore and Jack

For bore and jack areas, comply with Subarticles 1540-3 A & B except as follows:

For bore and jack areas, install metallic conduit at a minimum depth of 30 inches below finished grade or 6 inches below roadway sub-grade, whichever is greater. Provide 3 feet clearance to conduit from back of curb or from edge of pavement. Terminate ends of conduit into junction boxes.

Comply with the *NCDOT Policies and Procedures for Accommodating Utilities on Highway Rights-of-Way* in effect on the date of advertisement.

1715-4 MEASUREMENT AND PAYMENT

Tracer wire will be measured along the horizontal linear feet of tracer wire furnished, installed, and accepted. Measurement will be along the approximate centerline of the conduit system. Payment will be made in linear feet. No payment will be made for excess tracer wire in junction boxes and/or cabinets.

Unpaved trenching (qty)(size) & (qty)(size) will be measured horizontal linear feet of trenching for underground conduit installation of each type furnished, installed, and accepted. Measurement will be along the approximate centerline of the conduit system. Payment will be in linear feet.

Paved trenching (qty)(size) & (qty)(size) will be measured horizontal linear feet of trenching for underground conduit installation of each type furnished, installed, and accepted. Measurement will be along the approximate centerline of the conduit system. Payment will be in linear feet.

Plowing (qty)(size) & (qty)(size) will be measured horizontal linear feet of plowing for underground conduit installation furnished, installed, and accepted. Measurement will be along the approximate centerline of the conduit system. Payment will be in linear feet.

Directional drill (qty)(size) & (qty)(size) will be measured horizontal linear feet of directional drill for underground conduit installation furnished, installed, and accepted. Measurement will be along the approximate centerline of the conduit system. Payment will be in linear feet.

Bore and jack (qty)(size) & (qty)(size) will be measured in horizontal linear feet of bore and jack for underground conduit installation furnished, installed, and accepted. Measurement will be along the approximate centerline of the bore from junction box to junction box. Payment will be in linear feet.

No measurement will be made of vertical segments, non-metallic conduit, metallic conduit, sealing devices, backfill, graded stone, paved materials, miscellaneous fittings, pull lines, and seeding and mulching as these will be considered incidental to conduit installation.

Conduit will be paid for per linear foot based on quantity and size of conduits. As examples, an installation of a single1.25” HDPE conduit would be paid as:

Directional Drill (1)(1.25”)Linear Foot

An installation of two 1.25” and four 2” HDPE conduits would be paid as:

Directional Drill (2)(1.25”)&(4)(2”) Linear Foot

Payment will be made under:

Pay Item	**Pay Unit**
Tracer Wire	Linear Foot
Unpaved Trenching (qty)(size) & (qty)(size)	Linear Foot
Paved Trenching (qty)(size) & (qty)(size)	Linear Foot
Plowing (qty)(size) & (qty)(size)	Linear Foot

Directional Drill (qty)(size)	Linear Foot
Directional Drill (qty)(size) & (qty)(size)	Linear Foot
Bore and Jack (qty)(size) & (qty)(size)	Linear Foot

SECTION 1716
JUNCTION BOXES

1716-1 DESCRIPTION

Furnish and install junction boxes (pull boxes) with covers, graded stone, grounding systems, and all necessary hardware.

1716-2 MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Refer to Article 1098-5 Junction Boxes and Section 545 Graded Stone.

1716-3 CONSTRUCTION METHODS

Comply with Article 1411-3 Electrical Junction Boxes, except as follows:

Install junction boxes flush with finished grade. Do not install sealant compound between junction boxes and covers.

Install junction boxes where underground splicing of cable is necessary and where transitioning from below ground to above ground installation or vice-versa.

1716-4 MEASUREMENT AND PAYMENT

Junction box (_____) will be measured and paid in actual number of junction boxes of each size and type furnished, installed, and accepted.

No measurement will be made of covers, graded stone, and grounding systems as these will be considered incidental to furnishing and installing junction boxes.

Payment will be made under:

Pay Item	**Pay Unit**
Junction Box (_____)	Each

SECTION 1720
WOOD POLES

1720-1 DESCRIPTION

Furnish and install wood poles with grounding systems and all necessary hardware.

1720-2 MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Refer to Subarticles 1082-3(F) Treated Timber and Lumber – Poles and 1082-4(G) Preservative Treatment – Poles.

1720-3 CONSTRUCTION METHODS

Mark final pole locations and receive approval before installing poles. Unless otherwise specified, locate poles a minimum of 6 feet behind face of curb or 10 feet from edge of travelway.

Drill or auger a hole for placement of pole and to allow for compacting. Set pole at manufacturer's recommended depth, but at a minimum depth of 5 feet. Ensure the pole is within two degrees of vertical when fully loaded.

Backfill hole with pole installed and tamp backfill in 6 inch lifts with a mechanical tamp until compacted density is at least 95% of original density.

On new Department owned poles, install a grounding system consisting of number 4 or 6 AWG solid bare copper wire that is exothermically welded to a ground rod. Install ground wire so as to minimize damage from vandalism and environmental exposures. Install ground wire up pole to a point adjacent to the uppermost span. Use hot-dipped galvanized wire staples to secure ground wire to pole. Install ground rod at base of pole.

1720-4 MEASUREMENT AND PAYMENT

Wood pole will be measured and paid as the actual number of wood poles furnished, installed, and accepted.

No measurement will be made for installing grounding systems as these will be considered incidental to furnishing and installing wood poles.

Payment will be made under:

Pay Item	Pay Unit
Wood Pole	Each

SECTION 1721
GUY ASSEMBLIES

1721-1 DESCRIPTION

Furnish and install guy assemblies with all necessary hardware.

1721-2 MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Refer to Article 1098-6 Guy Assemblies.

1721-3 CONSTRUCTION METHODS

(A) Guy Assemblies for Signal Heads or Loop Lead-in Cable

Install guy assemblies with guy cable, guy guards, anchors, three-bolt clamps and associated fittings. Use two-bolt attachment method where there is adequate room on the pole to comply with the NESC. Attach guy assembly and guy cable to two separate bolts with one bolt for span and one bolt for guy cable.

Where adequate spacing is not available and a violation of the NESC would occur with the two-bolt attachment method, use approved one-bolt attachment method for attaching messenger cable and guy assembly.

Bond guy assembly to new pole grounding system as described in Section 1710-3.

Do not attach to existing guy assemblies unless specifically approved by owner.

(B) Guy Assemblies for Communications Cable

When installing messenger cable for supporting only communications cable, use approved one-bolt attachment method for attaching messenger cable and guy assembly.

Bond guy assembly to existing pole ground using Burndy Clamp (UCG25RS) or equivalent. If existing poles do not have a grounding system, install new grounding system for bonding guy assembly that complies with Article 1720-3.

Do not attach to existing guy assemblies unless specifically approved by owner.

1721-4 MEASUREMENT AND PAYMENT

Guy assembly will be measured and paid as the actual number of guy assemblies furnished, installed, and accepted.

No measurement will be made of guy cable, guy guards, anchors, clamps, or fittings as these will be considered incidental to furnishing and installing guy assemblies.

Payment will be made under:

Pay Item	Pay Unit
Guy Assembly	Each

SECTION 1722
RISER ASSEMBLIES

1722-1 DESCRIPTION

Furnish and install riser assemblies with clamp-on, aluminum weatherheads or heat shrink tubing, galvanized pole attachment fittings, and all necessary hardware.

1722-2 MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Provide rigid metallic conduit for risers. Refer to Subarticle 1098-4(B)(1) Rigid Metallic Conduit.

Provide Tyco™(Raychem™) part number 066193-000 or equivalent heat shrink tubing for the installation of fiber-optic or coaxial cable in new risers.

Provide Tyco™(Raychem™) part number FOSC-ACC-CABLE-SEAL-2-NW or equivalent heat shrink tubing retrofit kits for the installation of new fiber-optic or coaxial cable in existing riser with existing fiber-optic or coaxial cables.

1722-3 CONSTRUCTION METHODS

Install risers with required weatherheads or heat shrink tubing on poles using pole attachment fittings.

Install heat shrink tubing retrofit kits in existing risers as specified.

Use separate 1/2-inch riser with weatherhead for pedestrian pushbutton.

Use separate 1-inch riser with weatherhead for electrical service.

Use separate 2-inch riser with weatherhead for signal cables (bundled). Use separate 2-inch riser with weatherhead for the combination of all lead-in and twisted-pair communications cable. Install condulet on all risers for lead-in cable.

Use separate 2-inch riser with heat shrink tubing for fiber-optic communications cables and coaxial cable. Install risers with heat shrink tubing so that cable can be installed without violating its minimum bending radius. Install cable so it does not share a riser with any other cable.

Install heat shrink tubing in accordance with manufacturer's recommendations. Provide tubing a minimum of 5 inches in length with a minimum of 2.5 inches extended over cables and 2.5 inches extended over risers after heat has been applied. Use nylon filler rods with UV protection or equivalent, and sealing spacer clips to separate cables where multiple cables enter a riser. Ensure sealing spacer clips have a heat activated sealing compound with the sealing compound fully encapsulating the space between cables. Ensure heat shrink tubing provides a watertight fit around individual cables and outer walls of risers. Do not use cut sections of cable or any other devices in lieu of filler rods. Use aluminum tape around cables to prevent damage from sealing chemicals. Use a heat source that will provide even heat distribution around tubing. Ensure no damage occurs to any cables.

1722-4 MEASUREMENT AND PAYMENT

__" *Riser with* _____ will be measured and paid as the actual number of risers of each type and size furnished, installed, and accepted. No measurement will be made of weatherheads, heat shrink tubing, or pole attachment fittings as these will be considered incidental to furnishing and installing risers.

Heat shrink tubing retrofit kit will be measured and paid for as the actual number of heat shrink tubing retrofit kits furnished, installed, and accepted.

Payment will be made under:

Pay Item	Pay Unit
__" Riser with _____	Each
Heat Shrink Tubing Retrofit Kit	Each

SECTION 1725
INDUCTIVE DETECTION LOOPS

1725-1 DESCRIPTION

Furnish and install inductive detection loops with loop slot sealant, loop wire, conduit with fittings, and all necessary hardware.

1725-2 MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Refer to Article 1098-7 Inductive Detection Loops.

1725-3 CONSTRUCTION METHODS

All work performed in this section shall be done in the presence of the Engineer.

Notify Engineer one week before installing inductive detection loops.

Coordinate sawcutting and loop placement with pavement markings. For new construction or for resurfacing, install inductive detection loops before placing final layer of surface course. On unmarked pavement, pre-mark locations of stop lines and lane lines before locating inductive detection loops.

Before sawcutting, pre-mark inductive detection loop locations and receive approval. Sawcut pavement at approved pre-marked locations. Do not allow vehicles to travel over unsealed loop slots.

Install conduit with bushings from edge of pavement to junction box. Do not sawcut through curb.

Remove all loose material and wash saw slots with a high-pressure method using an air and water mixture. Dry saw slots with compressed air. Clear saw slots of jagged edges and protrusions. Seat loop conductor at bottom of saw slot without damaging loop wire.

Before sealing loop conductors, test that impedance from the loop wire to ground is at least 100 megohms. For each location with inductive loops, submit a completed Inductive Detection Loop & Grounding Test Results form and place copy in controller cabinet. Ensure all loops are included on form. The form is located on the Department's website.

Embed loop conductors in saw slot with loop sealant. Seal saw slot and dispose of excess sealant in an environmentally safe manner. Provide Engineer with Material Safety Data Sheet and manufacturer's test data.

Between corners of loops and junction boxes, twist loop conductor pairs a minimum of 5 turns per foot. Permanently label each twisted pair in the junction box with nylon cable tie using indelible ink. Indicate loop number and loop polarity on the tie.

1725-4 MEASUREMENT AND PAYMENT

Inductive loop sawcut will be measured and paid as the actual linear feet of inductive loop sawcut furnished, installed, and accepted.

No measurement will be made of loop slot sealant, loop wire, conduit, and conduit fittings as these will be considered incidental to furnishing and installing inductive detection loops.

Payment will be made under:

Pay Item	Pay Unit
Inductive Loop Sawcut	Linear Foot

SECTION 1726
LOOP LEAD-IN CABLE

1726-1 DESCRIPTION

Furnish and install loop lead-in cable with all necessary hardware.

1726-2 MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Refer to Article 1098-8 Loop Lead-In Cable.

1726-3 CONSTRUCTION METHODS

For underground runs, install lead-in cable in 2-inch non-metallic conduit. For aerial installation, wrap lead-in cable to messenger cable with at least four turns of wrapping tape spaced at intervals less than 15 inches or lash lead-in cable to messenger cable with one 360 degree spiral of lashing wire per 12 inches.

Where railroad preemption is required, install lead-in cable from signal controller cabinet to railroad company furnished and installed lockable junction box.

Splicing of lead-in cable will be allowed only for runs in excess of 750 feet. Splice lead-in cable in junction boxes or condulets on poles.

Test each complete loop system from the controller cabinet by using a megger to verify that impedance from the loop system to the ground is at least 50 megaohms. After successful completion of megger test, test loop system resistance using an electronic ohmmeter to verify loop system resistance is less than 0.00885 ohms per foot.

1726-4 MEASUREMENT AND PAYMENT

Lead-in cable (_____) will be measured and paid as the actual linear feet of lead-in cable of either 18-2 pair or 18-4 pair furnished, installed, and accepted. Measurement will be

made by calculating the difference in length markings located on outer jacket from start of run to end of run for each run. Terminate all cables before determining length of cable run. Measurement will be determined on 2-pair/4-pair combination resulting in the least number of linear feet.

If markings are not visible, measurement will be point to point with no allowance for sag. Twenty-five feet will be allowed for vertical segments up or down poles.

Payment will be made under:

Pay Item	Pay Unit
Lead-in Cable (_____)	Linear Foot

SECTION 1730
FIBER-OPTIC CABLE

1730-1 DESCRIPTION

Furnish and install single mode fiber-optic (SMFO) communications cable and drop cable assemblies with grounding systems, fiber-optic cable storage racks (snow shoes), communications cable identification markers, lashing wire, and all necessary hardware.

1730-2 MATERIAL

Refer to Article 1098-9 Fiber-Optic Cable.

1730-3 CONSTRUCTION METHODS

(A) General

Provide cable manufacturer's attenuation and Optical Time Domain Reflectometer (OTDR) testing data for each reel of cable upon request.

Install SMFO communications cable, snow shoes, communications cable identification markers, lashing wire, and all necessary hardware.

Comply with manufacturer's recommendations. Install communications cable on signal poles, utility poles, messenger cable, and in conduits as required to bring the fiber-optic cable into and, if necessary, out of each splice enclosure.

Take all precautions necessary to ensure cable is not damaged during storage, handling, and installation. Do not violate minimum bending radius of 20 times the radius of cable diameter or manufacturer's recommendation, whichever is greater. Do not step on cable nor run over cable with vehicles or equipment. Do not pull cable over or around obstructions, or along the ground.

Determine lengths of cable necessary to reach from termination-point to termination-point. Install cable in continuous lengths between approved splicing facilities. Additionally, provide a sufficient amount of slack cable to allow for an additional 20 feet of cable to be present after removal of outer sheath for termination. Measure slack cable by extending cable straight out of cabinet door.

Keep cable ends sealed at all times during installation to effectively prevent the ingress of moisture. Use approved heat shrink cable end cap. Do not use tape to seal cable ends.

Before installing cable, provide three copies of cable manufacturer's recommended and maximum pulling tension. Do not exceed manufacturer's recommended pulling tension. Use pulling grips containing a rotating swivel. Coil cable in a figure-8 configuration whenever cable is unreeled for subsequent pulling.

Install fiber-optic cable in separate 2-inch risers with heat shrink tubing or conduits. Do not share risers or conduits containing fiber-optic cable with other type cable.

(B) Aerial Installation

Double lash fiber-optic cable to messenger cable with one 360 degree spiral per foot.

Use pole attachment hardware and roller guides with safety clips to install aerial run cable.

Maintain tension during the pulling process for aerial run cable by using an approved mechanical clutch (dynamometer) device. Do not allow cable to contact the ground or other obstructions between poles during installation. Do not use a motorized vehicle to generate cable pulling forces.

Use a cable suspension clamp when attaching cable tangent to a pole. Select and place cable blocks and corner blocks so as not to exceed the cable's minimum bending radius. Do not pull cable across J-hooks.

Store 100 feet of each fiber-optic cable on all cable runs that are continuous without splices where specified. Obtain approval for spare cable storage locations. Store spare fiber-optic cable on fiber-optic cable storage racks (snow shoes). Locate spare cable storage in the middle of spans between termination points. Do not store spare fiber-optic cable over the roadway or driveways.

Install one communications cable identification marker within 36 inches of pole attachment points and at locations where more than one cable originates or terminates.

(C) Underground Installation

Install fiber-optic cable underground in conduit using cable pulling lubricants recommended by the fiber-optic cable manufacturer.

Obtain approval of cable pulling lubricant and method of pulling before installing underground fiber-optic cable.

Use a dynamometer (clutch device) so as not to exceed maximum allowable pulling tension if cable is pulled by mechanical means. Do not use a motorized vehicle to generate cable pulling forces.

Keep tension on cable reel and pulling line at start of each pull. Do not release tension if pulling operation is halted. Restart pulling operation by gradually increasing tension until cable is in motion.

For pulling cable through manholes, junction boxes, and vaults, feed cable by manually rotating the reel. Do not pull cable through intermediate junction boxes, handholds, or openings in conduit unless otherwise approved.

Install communications cable identification markers on each communications cable entering a junction box.

(D) Installation of Drop Cable Assembly

Determine length of drop cable needed, including slack, to reach from termination point to termination point.

At aerial splice enclosures, store 100 feet of slack cable on cable storage racks. At below ground splice enclosures, coil 100 feet of slack cable in manhole or junction box where enclosure is located.

At equipment cabinet end of drop cable assembly, terminate all fibers with ST-PC connectors to the connector panel. Label all connectors, pigtails, and the connector panel. At the aerial splice enclosure location, cap off all unused fibers and label to correspond with the connector panel.

1730-4 MEASUREMENT AND PAYMENT

Communications cable (____-fiber) will be measured and paid as the actual linear feet of fiber-optic cable of each fiber count furnished, installed, and accepted. Measurement will be made by calculating the difference in length markings located on outer jacket from start of run to end of run for each run. Terminate all fibers before determining length of cable run.

Drop cable will be measured and paid as linear feet of fiber-optic drop cable assemblies furnished, installed, and accepted. Sag and vertical segments will not be paid for as these distances are considered incidental to the installation of drop cable assemblies.

No measurement will be made for terminating, splicing, and testing fiber-optic cable, communications cable identification markers, or fiber-optic cable storage racks, as these will be considered incidental to the installation of fiber-optic cable.

Payment will be made under:

Pay Item	Pay Unit
Communications Cable (____-Fiber)	Linear Foot
Drop Cable	Linear Foot

SECTION 1731
FIBER-OPTIC SPLICE CENTERS

1731-1 DESCRIPTION

Furnish and install fiber-optic interconnect centers, fiber-optic splice enclosures, and all necessary hardware.

1731-2 MATERIALS

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Refer to Article 1098-10 Fiber-Optic Splice Centers.

1731-3 CONSTRUCTION METHODS

(A) General

Install interconnect centers with connector panels, splice trays, storage for slack cable or fibers, mounting and strain relief hardware, and all necessary hardware.

Install splice enclosures with splice trays, basket containment assemblies, racking for slack cable or fibers, mounting and strain relief hardware, and all other necessary hardware.

Fusion splice and secure SMFO cable in splice trays inside the splice enclosure. Ensure all buffer tubes are contained within splice trays so no bare fibers are outside tray.

Do not exceed 0.05 dB of attenuation per splice.

Furnish strain relief so that no tensile force is on SMFO cable when it is held within the interconnect center or splice enclosure.

Do not damage fiber or violate the minimum bending radius of the fiber.

(B) Termination and Splicing within Interconnect Center

Terminate and splice all fibers including unused fibers.

Label all fiber-optic connectors, whether on jumpers, connector panels, or other equipment, to prevent improper connection. Obtain approval of fiber-optic connector labeling method.

For all fibers designated for termination to connector panel within interconnect center, fusion splice fibers to pigtails.

For all cut fibers designated to pass through interconnect center, fusion splice fibers.

For all buffer tubes designated to pass through interconnect center, neatly coil excess tubing inside interconnect center.

(C) Termination and Splicing within Splice Enclosure

Fusion splice all fibers including fibers designated to be coupled with fibers from a drop cable assembly and cut fibers designated to pass through splice enclosure.

For all buffer tubes designated to pass through splice enclosure, neatly coil excess tubing inside basket provided with enclosure.

Label all fiber-optic splices. Obtain approval of fiber-optic connector labeling method.

Install heat shrink cable shields using methods recommended by the manufacturer of the enclosure. Perform a pressurization flash test on enclosure in accordance with

manufacturer's recommended procedures at the conclusion of splicing procedure and before final placement of enclosure.

For aerial installations, secure enclosures to messenger cable using manufacturer supplied hardware. Secure SMFO cable and drop cable assemblies to snowshoes.

Install enclosures with enough slack cable to allow enclosure to be lowered to ground level and extended into a splicing vehicle.

For underground, manhole, and junction box facility installations, place the enclosure along with required spare cables in the facility in a neat and workmanship like manner.

(D) Testing

Provide written notification a minimum of ten days before beginning OTDR tests.

After splicing is completed, perform bi-directional OTDR tests on each fiber, including unused fibers. Install a 1000 foot pre-tested launch cable between the OTDR and fiber optic cable to be tested.

Ensure fusion splice losses do not exceed 0.05 dB and connectors have a loss of 0.5 dB or less. If any fiber exceeds maximum allowable attenuation or if fiber properties of the cable have been impaired, take appropriate actions up to and including replacement of the fiber cable. Corrective action will be at no additional cost to the Department

Clearly label each OTDR trace identifying a starting and ending point for all fibers being tested. Record the attenuation level of each fiber and clearly indicate OTDR trace results in report format. Furnish one hard copy of each of the OTDR trace results and electronic copies of all trace results on a compact disk. Furnish the manufacturer's make, model number, and software version of the OTDR used for testing.

1731-4 MEASUREMENT AND PAYMENT

Interconnect center will be measured and paid as the actual number of fiber-optic interconnect centers furnished, installed, and accepted.

Splice enclosure Actual number of fiber-optic splice enclosures furnished, installed, and accepted. No measurement will be made between aerial, underground, manhole, or junction box installation of the fiber-optic splice enclosure.

No measurement will be made of splice trays, pigtails, jumpers, connector panels, and testing, as these will be considered incidental to furnishing and installing fiber-optic interconnect centers and splice enclosures.

Payment will be made under:

Pay Item	Pay Unit
Interconnect Center	Each
Splice Enclosure	Each

SECTION 1732
FIBER-OPTIC TRANSCEIVERS

1732-1 DESCRIPTION

Furnish and install fiber-optic transceivers with all necessary hardware.

1732-2 MATERIALS

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Refer to Article 1098-11 Fiber-Optic Transceivers.

1732-3 CONSTRUCTION METHODS

Install fiber-optic transceivers in each equipment cabinet and comply with manufacturer's installation instructions.

1732-4 MEASUREMENT AND PAYMENT

Actual number of fiber-optic drop and repeat transceivers furnished, installed, and accepted.

Actual number of fiber-optic self-healing ring transceivers furnished, installed, and accepted.

Payment will be made under:

Pay Item	Pay Unit
Fiber-Optic Transceiver – Drop and Repeat	Each
Fiber-Optic Ttransceiver – Self-Healing Ring	Each

SECTION 1733
DELINEATOR MARKERS

1733-1 DESCRIPTION

Furnish and install delineator markers with all necessary hardware.

1733-2 MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Refer to Article 1098-12 Delineator Markers.

1733-3 CONSTRUCTION METHODS

Submit sample of proposed delineator markers for approval before installation.

Install delineator markers using a method that firmly and securely anchors delineator marker in the ground to prohibit twisting and easy removal.

1733-4 MEASUREMENT AND PAYMENT

Actual number of delineator markers furnished, installed, and accepted.

Payment will be made under:

Pay Item	Pay Unit
Delineator Marker	Each

SECTION 1734
REMOVE EXISTING COMMUNICATIONS CABLE

1734-1 DESCRIPTION

Remove existing communications cable.

1734-2 CONSTRUCTION METHODS

Removal of existing aerial communications cable also includes proper disposal of communications cable, messenger cable and mounting hardware, including abandoned risers.

Removal of existing underground communications cable includes proper disposal of communications cable and junction boxes, if required. Where junction boxes have been removed, backfill hole to 95% of surrounding density.

Do not reuse any removed communications cable, messenger cable, junction boxes, pole attachment hardware or abandoned risers on the project, unless otherwise specified. In the event that any of the removed communications cable, junction boxes or pole attachment hardware is to be returned to the Engineer, it will be so noted on the plans.

1734-3 MEASUREMENT AND PAYMENT

Remove existing communications cable will be measured in horizontal linear feet of existing communications cable removed and accepted. Payment will be in linear feet. Sag, vertical segments, or spare segments of communications cable will not be paid for as these distances will be considered incidental to the removal of existing communications cable.

No additional measurement will be made for multiple cables being removed from the same conduit or same pole. Where multiple adjacent conduits exist (each containing multiple cables), each conduit will be considered separately for purposes of payment. No payment will be made for cable that cannot be removed and is abandoned in place.

No measurement will be made of the removal of messenger cable, pole attachment hardware, and junction boxes, as these will be considered incidental to removing existing communications hardware.

Payment will be made under:

Pay Item	Pay Unit
Remove Existing Communications Cable	Linear Foot

SECTION 1735
CABLE TRANSFERS

1735-1 DESCRIPTION

Remove and reinstall existing communications cable for pole relocations.

1735-2 CONSTRUCTION METHODS

During project, transfers of existing communications cable to new poles may be required. Perform transfers as directed by the Engineer. Remove existing cables from pole to be removed and reinstall these cables and any existing attachment hardware on new pole. Remove all communications hardware from existing pole. Furnish and install any new attachment hardware as required.

1735-3 MEASUREMENT AND PAYMENT

Cable transfer will be measured and paid as the actual number of cable transfers with attachment hardware to new poles furnished, installed, and accepted.

Payment will be made under:

Pay Item	Pay Unit
Cable Transfer	Each

SECTION 1743
SIGNAL PEDESTALS

1743-1 DESCRIPTION

Furnish and install signal pedestal assemblies with foundations, grounding systems, and all necessary hardware.

1743-2 MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Refer to Article 1098-13 Pedestals.

1743-3 CONSTRUCTION METHODS

Locate foundations, determine elevation, and submit findings. Obtain the Engineer's approval of foundation locations and elevations before constructing foundations.

Excavate in accordance with Section 410 Foundation Excavation. If encountered, remove rock or boulders to a depth sufficient to obtain stability necessary to support the structure for design loads. Ensure ground is level before installing foundations.

Construct foundations in accordance with Section 825 Incidental Concrete Construction. Cast concrete for pole foundations against undisturbed soil unless otherwise permitted. Provide forms with chamfer strips that measure one inch along diagonal face at all corners above ground level. Do not install foundations over uncompacted fill or muck. Install conduit in foundations.

Securely place, position, and align anchor bolts symmetrically about the center of foundation.

Give exposed vertical concrete surfaces an ordinary surface finish. Give exposed horizontal surfaces a float finish.

Level tops of concrete foundations. Do not allow tops to exceed 6 inches above adjacent ground surface. Pour and finish foundation to a level flush with surrounding sidewalk when possible.

Do not erect pedestals until concrete has attained a minimum compressive strength of 2500 psi as determined by cylinder breaks.

1743-4 MEASUREMENT AND PAYMENT

Signal pedestal with foundation will be measured and paid as the actual number of signal pedestals with foundations furnished, installed, and accepted.

Payment will be made under:

Pay Item	Pay Unit
Signal Pedestal with Foundation	Each

SECTION 1745
SIGNS INSTALLED FOR SIGNALS

1745-1 DESCRIPTION

Furnish and install signs for signals with cable hangers, rigid sign mounting brackets, U-channel posts, and all necessary hardware.

1745-2 MATERIAL

Comply with Article 901-2 Sign Fabrication.

Use Type III retroreflective sheeting, except for black sheeting. Use non-reflective for black sheeting.

Conform to the message layout, size, and color as required in the *MUTCD*.

For messenger cable mounting, furnish either messenger cable hangers with free-swinging, 360 degree adjustable sign brackets or three bolt clamps as directed. Furnish aluminum, galvanized steel, or stainless steel sign supporting hardware.

For ground mounting, furnish steel, 3 lb., U-channel posts with hardware for ground mounting. Comply with Article 903-2 Sign Supports.

For mast-arm mounting, furnish rigid aluminum, galvanized steel or stainless steel sign mounting brackets.

1745-3 CONSTRUCTION METHODS

Install signs with applicable mounting hardware. Comply with sign offsets and mounting heights as shown in the *MUTCD* and Standard Drawing numbered 904.50.

For messenger cable mounting, install signs 6 inches minimum from signal heads.

For ground mounting, comply with Article 903-3 Ground Mounted Supports.

For mast arm mounting, install attachment brackets to allow adjustment so signs:

are aimed in required direction,
are plumb as viewed from respective approaches,
may be tilted forward or backward as required, and
may be raised or lowered on mast arm throughout full length of sign.

1745-4 MEASUREMENT AND PAYMENT

Sign for signals will be measured and paid as the actual number of signs for signals, regardless of mounting method, furnished, installed, and accepted.

Payment will be made under:

Pay Item	Pay Unit
Sign for Signals	Each

SECTION 1750
SIGNAL CABINET FOUNDATIONS

1750-1 DESCRIPTION

Furnish and install signal cabinet foundations and all necessary hardware.

Furnish either poured concrete foundations or preformed cabinet pad foundations and all necessary hardware. Obtain approval of foundation type.

1750-2 MATERIAL

Preformed cabinet pad foundation material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Refer to Article 1000-4 Portland Cement Concrete and Article 1098-14 Signal Cabinet Foundations.

1750-3 CONSTRUCTION METHODS

Comply with Section 825 Incidental Concrete Construction-General.

Obtain approval for final cabinet foundation locations before pouring concrete base. Locate new cabinets so as not to obstruct sight distance of vehicles turning on red.

Do not install foundations over uncompacted fill or muck.

Use procedures, equipment, and hardware as follows:

Hand tamp soil before placing concrete.

Maintain 12 inches minimum from service pole to closest point on foundation unless otherwise approved.

Use a minimum of four 1/2-inch diameter expanding type anchor bolts to secure cabinet to foundation.

Install minimum 4 inches above and 4 inches below finished grade.

Locate external stubbed out conduit at cabinet foundation so conduit is in middle of cabinet. Provide service conduit as the rightmost conduit coming into cabinet. Provide two spare conduits stubbed out; one pointed toward service pole and the other toward direction of lead-in cable. Inscribe identification arrow in foundation indicating direction of spare conduits.

Give cabinet foundation a broom finish.

Seal space between cabinet base and foundation with permanent, flexible, waterproof sealing material.

If using preformed cabinet pad, ensure ground is level before installation.

1750-4 MEASUREMENT AND PAYMENT

Signal cabinet foundation will be measured and paid as the actual number furnished, installed, and accepted.

Payment will be made under:

Pay Item	Pay Unit
Signal Cabinet Foundation	Each

SECTION 1751
CONTROLLERS WITH CABINETS

1751-1 DESCRIPTION

Furnish and install controllers with cabinets and all necessary hardware. Furnish all pole or foundation mounting hardware, detector sensor cards, external electrical service disconnects, one Corbin Number 2 cabinet key, one police panel key, conflict monitors or malfunction management units, surge protection, grounding systems, AC/DC isolator cards, and all necessary hardware.

1751-2 MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL. Refer to the contract.

1751-3 CONSTRUCTION METHODS

(A) General

Remove existing controllers and cabinets where required. Remove maintenance diary from cabinet and place in new cabinet or deliver to the Engineer. Take existing equipment out of service only at the time directed.

Locate new cabinets so as not to obstruct sight distance of vehicles turning on red.

Install controllers, cabinets, detector sensor units, and hardware that provide required phasing, color sequence, flash sequence, interconnection, railroad clearance and preemption, and emergency vehicle clearance and preemption.

Stencil signal inventory number on cabinet side facing roadway. Use 3 inch black characters.

Provide external electrical service disconnect at all new and existing cabinet locations unless otherwise specified.

Do not program controller for late night flashing operation at railroad preemption installations. For all other installations, do not program controller for late night flashing operation unless otherwise directed. Ensure all signal heads for same approach flash concurrently during flashing operation.

Provide serial number and cabinet model number for each new controller and controller cabinet installed.

Install pole mounted cabinets so height to cabinet middle is 4 feet.

Activate controllers with proposed phasing and timing.

(B) System Interconnection

When interconnection of signals is required, install interface equipment and hardware for signals. Demonstrate proper operation of interconnection using manual commands after interconnection is complete.

Program telemetry command sequences and enable devices necessary for testing of communication between local controllers and field master controllers, and between field master controllers and Department-furnished central computer.

(C) Workshop

Provide enclosed workshop to set up and test new controllers and cabinets before installation. Locate workshop within Division responsible for project administration. Ensure workshop provides protection from weather and sufficient space to house two test observers, all necessary test equipment and material, controllers and cabinets.

Configure and test each controller and cabinet to match the proposed signal design. Ensure all equipment furnished and installed or modified by the Contractor at each location operates in full compliance with the plans and project special provisions. Test each controller and cabinet for proper color sequence, flashing operation, phase timings, preemption, coordination, and conflict monitor programming or malfunction management unit programming. Ensure that simultaneous conflicting phase outputs

will cause the cabinet to revert to flashing operation. For intersections with any type of preemption, submit a completed Preemption Test Procedure Checklist. The checklist is located on the Department's website.

Test the cabinet and controller for eight hours minimum. Following this test, and before installation, the Engineer will inspect the equipment in operation. The Engineer may require other tests to ensure proper operation. These tests shall be at no additional cost to the Department.

1751-4 MEASUREMENT AND PAYMENT

Controllers with cabinets (____) will be measured and paid as the actual number of each type of controllers with cabinets furnished, installed, and accepted.

Detector cards will be measured and paid as the actual number furnished, installed, and accepted.

No measurement will be made of conflict monitors, malfunction management units, external electrical service disconnect, grounding systems, modems, meter bases, and workshop as these will be considered incidental to furnishing and installing controllers with cabinets.

Payment will be made under:

Pay Item	Pay Unit
Controller with Cabinet (_____)	Each
Detector Card (_____)	Each

SECTION 1753
CABINET BASE ADAPTER/EXTENDER

1753-1 DESCRIPTION

Furnish and install cabinet base adapters and extenders with all necessary hardware for 170 Cabinets.

1753-2 MATERIAL

Refer to Article 1098-15 Cabinet Base Adapter/Extender.

1753-3 CONSTRUCTION METHODS

Install cabinet base adapter at locations requiring new Model 332A cabinet on existing/modified foundation.

Install cabinet base extender at locations requiring new Model 332A cabinet on new foundation or existing Model 332A cabinet that does not have cabinet base extender.

Where Model 336 cabinet is used as base mount cabinet, install adapter or extender, as required.

Use permanent, flexible waterproof sealing material to:

- Seal between cabinet base and cabinet base adapter/extender,
- Seal two-piece cabinet base adapter/extender seams, and
- Seal space between cabinet base adapter/extender and foundation.

1753-4 MEASUREMENT AND PAYMENT

Cabinet base adapters will be measured and paid as actual number furnished, installed, and accepted.

Cabinet base extenders will be measured and paid as the actual number furnished, installed, and accepted.

Payment will be made under:

Pay Item	Pay Unit
Cabinet Base Adapter	Each
Cabinet Base Extender	Each

SECTION 1755
BEACON CONTROLLER ASSEMBLIES

1755-1 DESCRIPTION

Furnish and install beacon controller assemblies with cabinets. Furnish all pole mounting hardware, solid state flashers, one Corbin Number 2 cabinet key, surge protection, grounding systems, and all necessary hardware.

1755-2 MATERIAL

Refer to Article 1098-16 Beacon Controller Assemblies.

1755-3 CONSTRUCTION METHODS

Remove existing beacon controller assemblies where required. Remove maintenance diary from cabinet and place in new cabinet or deliver to the Engineer. Take existing equipment out of service only at the time directed.

Locate new beacon controller assemblies so as not to obstruct sight distance of turning vehicles.

Install new beacon controller assemblies. Provide external electrical service disconnect at new and existing cabinet locations unless otherwise specified.

Stencil signal inventory number on cabinet side facing roadway. Use 3-inch black characters. Provide serial number and cabinet model number for each new beacon controller assembly.

Install pole mounted cabinets so height to cabinet middle is 4 feet.

1755-4 MEASUREMENT AND PAYMENT

Beacon controller assembly and cabinet (_____) will be measured and paid for as the actual number furnished, installed, and accepted.

No measurement will be made of surge protectors, external electrical service disconnect, grounding systems, and removing existing beacon controller assemblies as these are considered incidental to furnishing and installing beacon controller assemblies.

Payment will be made under:

Pay Item	**Pay Unit**
Beacon Controller Assembly and Cabinet (_____)	Each

NCDOT

Major Changes and Revisions

for the

Standard Specifications for Roads and Structures

2006

February 10, 2006

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General comments

Metric measurements were removed.
Measurement and Payment were combined into one section
Some renumbering in subsections for consistency throughout the Book

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DIVISION 1 GENERAL REQUIREMENTS

Electronic Bidding requirements were added from Project Special Provisions to appropriate sections.

101-2 Added abbreviations incorporated from other Divisions

101-3 - 101-97 were renumbered.

102-2 Prequalification was rewritten

106-1 (B) Added Domestic Steel requirements from Project Special Provision.

107-13 (A) Requirements for groundcover changed from 30 days to 21 days.

107-13 (D) Water and Air Pollution was rewritten

107-22 Requirement to wear safety vest

107-27 Fines levied against the Department; new section

109-3 Force Account revised from Project Special Provision

109-4 Partial Payments incorporated from Project Special Provision

109-8 Fuel Adjustments revised to change adjustment to 0%; incorporated from Project Special Provision

DIVISION 2 EARTHWORK

200-1 Removed statement that excluded clearing and grubbing at structure sites.

200-7 Removed paragraph concerning clearing and grubbing of borrow sources furnished by the Department.
Deleted pay item Clearing and Grubbing of Borrow and Material Sources.

205-2 Added statement that well abandonment must be performed by a Certified Well Contractor.

210-5 Added statement that Engineer may have asbestos removal performed by others when the asbestos is discovered after the opening of bids.

215-5 Added statement that Engineer may have asbestos removal performed by others when the asbestos is discovered after the opening of bids.

225-2 Incorporated project special provision entitled Roadway Excavation.

228 Deleted Entire Section 228 Pre-Splitting of Rock. Will be revised and included as project special provision when needed.

230-4 (B) Deleted Department Furnished Sources. Will be a project special provision when needed.

230-4 Contractor Furnished Sources-Added statement concerning borrow and waste site reclamation procedures being available on the web.
Incorporated Special Provision entitled *Contractor Borrow Source*.

270-3 Added new language concerning operating heavy equipment on the fabric; also revised language concerning joints in the fabric.

DIVISION 3 PIPE CULVERTS

300-5 Removed first sentence concerning invert elevations.

300-6 (B) Added paragraph concerning rod and lug coupling bands.

320-3 (B) Change to require Contractor to determine amount of camber in a line of pipe.

330 Welded Steel Pipe- Section completely re-written to provide for installations in soil and not in soil. Adjusted pay items accordingly.

DIVISION 4 MAJOR STRUCTURES

410-3 Moved Clearing and Grubbing references to Section 200.
Removed references to shoring. Information included in shoring

410-5 Deleted Cofferdams; made Project Special Provision, section renumbered.

420-3 Following changes:

- Added language to describe requirements for SIP forms with excluder plates or styrofoam void fillers
- Added language to describe embedded clips for SIPs used with prestressed concrete girders

Incorporated Project Special Provision – Falsework and forms over or adjacent to traffic

420-8 Removed Article for Foundation Seals; renumbered Section

420-10 Deleted use of hot poured rubber asphalt for expansion joints

420-13 Incorporated Project Special Provision – Adhesively anchored anchor bolts or dowels

420-16 Added language to clarify form removal requirements for box culvert walls

420-20 Added language to clarify requirements for placing traffic on bridge decks as it relates to slip forming concrete barrier rail

425-5 Incorporated previous Project Special Provision –Mechanical Butt Splices

430-6 Added requirements for Box Beams

442-7 Revised language to allow shop painting of all coats for System 1.

442-11 Added SSPC QP1 certification requirement

442-13 Changed SSPC Guide Spec to 6; added SSPC QP2 certification requirement

445 Deleted entire section for timber structures

450 Section totally reworded with the following changes:
Deleted preaugering through embankments except where necessary for driving concrete piles:

- Revised language to only require embankment construction to bottom of cap (in lieu of subgrade elevation) unless noted otherwise on the plans
- Deleted references to determination of pile length by the Engineer
- Deleted references to test piles
- Deleted references to drop hammers
- Restricted submittal for pile driving methods and equipment to 2 hammers per pile type per submittal. Reduced review time to 20 working days.

- Specified acceptable range of blows per foot at the required bearing capacity. Required variable energy hammer for concrete piles.
- Addressed installation of piles with vibratory hammers.
- Addressed inspection and replacement of the hammer cushion.
- Defined allowable driving stresses and conditions upon which driving piles may be stopped.
- Addressed galvanizing steel piles. Added pay item for galvanized steel piles.
- Clarified use of the wave equation.
- Defined practical refusal.
- Clarified the option to drive pile to grade in lieu of cutting off the pile.

452 Section totally reworded with the following changes:

- Clarified section to apply to only permanent sheet pile retaining walls.
- Addressed installation of sheet piles with vibratory hammers.
- Addressed inspection and replacement of the hammer cushion.
- Defined allowable driving stresses and conditions upon which driving piles may be stopped.
- Addressed pile cushions for concrete sheet piles.
- Deleted timber sheet piles.
- Added concrete coping and backfilling behind wall.
- Revised pay item to pay for exposed face area only per square foot with single pay item, Sheet Pile Retaining Walls.

453 (Formerly Section 842):

- Addressed foundation material, weep holes, surface finish, joints, removal of forms, brick veneer, drains and backfilling for gravity retaining walls.
- Revised pay item to pay for exposed face area only per square foot with single pay item, Gravity Retaining Walls.

454 Deleted references to cut back asphalt and asphalt plank
Reduced number of methods for waterproofing and dampproofing to one each

460 Included Barrier Rail Delineators in description and payment for such incidental to barrier rail

462 Deleted references to concrete block slope protection and stone slope protection

DIVISION 5 SUBGRADE, BASES AND SHOULDERS

501-8 (A) In the second sentence of the first paragraph, the 40 days was changed to 24 calendar days to accommodate contractor's requests. The same results can be accomplished in the shorter time period.

501-15 Asphalt curing seal and blotting was separated into their own subarticles for aesthetics.

520-3 Deleted Subarticles 520-3(A) and (B) and reworded article 520-3 for clarity. (Redundant)

520-5 Changed references directly to Division 10 instead of routing through different articles.

520-6 Referenced Article 1010-1 and 1010-2. The majority of this article was deleted because it was redundant.

520-11 The Table reference was changed to Section 1010 and reworded for clarity.

530-4(C) Referenced Subarticle 230-4(C) and deleted redundancy.

540-3 Revised the seasonal limitations to be covered by December 1 of the same year.
Revised the Articles reference associated with other items of work due to Method of Measurement and Basis of Payment being combined.

540-5 Revised the reference for Table 540-2 to Table 1010-4.

540-10 Changed first paragraph to the active voice. Referenced Article 1010-4. The majority of this article was deleted because it was redundant.

540-14 Two line items related to road mixed CTBC were deleted because they are obsolete.

542-3 Revised the Articles reference associated with other items of work due to Method of Measurement and Basis of Payment being combined.

542-7 In the second sentence of the first paragraph, the 40 days was changed to 24 calendar days to accommodate contractor's requests. The same results can be accomplished in the shorter time period.

542-8 In the first sentence of the second paragraph, the allowable moisture content was changed from +/- 2% from optimum to between Optimum and +2%. This is in an effort to provide enough moisture in the soil to have the cement hydrate.

542-17 This Article was combined with Article 540-16 for consistency throughout the *Specifications Book*.

DIVISION 6 ASPHALT PAVEMENTS

600-2 Contract documents was substituted for Special Provisions as an editorial change.

600-5 The last paragraph of this section was moved to the first paragraph of Article 600-9 Measurement and Payment.

605-8 A new paragraph was added to address the tracking and accumulation of tack coat material on existing and newly constructed pavements.

607-1 Contract documents was substituted for plans and special provisions as an editorial change.

607-2 Minor editorial changes that do not affect the intent of the Specifications.
Equip milling machines with an electronic control system to control the longitudinal profile.
Allowed the use of a 24-foot non-contacting mobile string system.

607-3 Minor editorial changers that do not affect the intent of the Specifications.
Removed specific equipment used to clean the pavement to be more end result oriented.

607-4 This Article was rewritten to clarify that the millings are not to be considered a commodity. The Department reserves the right to delete any portion of the work without paying an increase in unit cost for asphalt.

609-4 Changed wording to allow the mix to be verified on either NCDOT production or private production.

609-5 Clarify the issue of what material is to be paid for when.

609-5(C)(1) Process control samples defined as quality control samples taken at times other than the scheduled or directed sample tonnage.
Process control samples should not be plotted on the control charts or reported to the QA laboratory.

Section/Article

609-5(C)(2) The full and partial test series letters was changed for editorial purposes.
ASTM D 2041 was taken out of the Maximum Specific Gravity test.
Moved recycled shingle material just below recycled pavement material for aesthetics.

609-6(C)(2)F Deleted the requirement for N_{max} based on Dr. Brown's of NCAT comments. The uncompacted void content for natural sands was also eliminated. The APA provision coupled with N_{ini} will allow the industry to use more natural sands in their mixes without fear rutting will be an issue.

609-5(C)(3) This Subarticle better defined what test results should be plotted on the control charts.

609-5(C)(6) Allowed the contractor's Level II Superpave technician to resume normal production after a required or elected stoppage provided they notified the appropriate QA Supervisor and submitted the results from the mix verification tests.

609-5(D)(1) The types of pavement required to be tested for density control was broken into separate numbers for clarity.

609-5(D)(2) Immediately was more clearly defined as within one working day of the sample being taken for filling core sample holes. Tack should be properly applied to the holes before the mix is compacted.

609-5(E) Observations was changed to activities for clarity. Process Control test results are the for the Contractor's informational purposes only.

609-6 The option of having the QA Laboratory jointly perform the verification TSRs was removed. Contractors must provide the results to the QA lab within 7 calendar days.

610-2 The material section referenced for Anti-strip additive (chemical) was updated to Article 1020-8

610-3(A) Submit a mix design using a Department certified mix design technician.
AASHTO PP28 was updated to AASHTO R 35.
The gyratory printouts for specimens compacted to N_{max} was deleted as a requirement for the design process.
Type S 9.5D was added as a Standard Mix Type.

610-3(A)(4) The current bulk and apparent specific gravity should be used for the aggregate properties. The uncompacted void content of natural sand for Type C and D mixes is no longer required, however, APA samples will be required to determine rut potential.

610-3(A)(7) The Brand Name was substituted for Name of Product.

610-3(A)(9) AASHTO PP2 test procedure was renamed R30, and AASHTO PP28 was renamed R35

610-3(A)(11) The restricted zone requirements were dropped for the 0.45 power chart.

610-3(A)(13) The contractor will have to submit the TSR test data for Mix designs prior to approval.
In addition to the required mix design submittal forms, 6 compactor specimens are required to be delivered to M&T's central lab for APA testing for rut susceptibility.
Submit materials to the M&T asphalt design laboratory representative samples of each mix component. These samples should be submitted to the design lab 20 days prior to the anticipated beginning. (This change allows M&T more time to compile the materials and perform a verification test.)

Section/Article

610-3(B) Surface mix designs will be tested for rutting susceptibility. The approval criterion is listed in Table 610-2. Mix designs that fail to meet these requirements will be considered unacceptable and must be redesigned such that rut depths are acceptable.

610-3(C) The mixing temperatures will be established for mixes listed in Table 610-2 between 265 and 350.

Table 610-2 was modified to include max rut depth criteria for surface mixes, and eliminated the N_{max} criteria.

610-7 Removed the requirement that the truck beds must be made of metal. Truck beds must be sprayed with an approved release agent material.

610-8 The material transfer device will be used on any and all mixes which have a binder of PG 76-22. The equipment and laydown requirements are discussed within.

610-10 The last paragraph in this article was removed because it was repetitive. The first paragraph in 609-5(D)(1) already contained this direction.

610-13 Simultaneously was taken out of the exception for the determination of lots for density

620-2 The last two paragraphs of this article were moved to Article 620-3.

620-4 Adjustments to the unit price for asphalt binder will be based on the actual terminal price. No longer will the cost of asphalt have to exceed 5% from the base price index.

650-3(B) Submit materials to the M&T asphalt design laboratory representative samples of each mix component. These samples should be submitted to the design lab 20 days prior to the anticipated beginning. (This change allows M&T more time to compile the materials and perform a verification test.)

650-4 The requirements of retention coating was deleted from Table 650-1 because Dept. does not perform test.

650-5 The same seasonal limitations for all final inch asphalt surface mixes was placed on the OGAFC.

The minimum air temperature for Type FC-1 and FC-2 Modified mixes was set at 60 degrees. The MTV should be used when placing PG 76-22.

650-6 The article was renamed Quality Management System to reduce confusion that it is a QMS for all asphalt pavements.

652-3 The contractor is to submit a mix design and the proposed job mix formula for approval.

652-3(B) Submit materials to the M&T asphalt design laboratory representative samples of each mix component. These samples should be submitted to the design lab 20 days prior to the anticipated beginning. (This change allows M&T more time to compile the materials and perform a verification test.)

657 New Section: *Sealing Existing Pavement Cracks and Joints* from Project Special Provision

660 Section updated; removed the types of surface treatments that the Department no longer uses; also added a provision for Slurry Seals.

661 New section for Ultra Thin bonded wearing course was incorporated from the project special provisions.

663 New Section, *Hot-In-Place Recycled Asphalt Concrete* from Project Special Provision

665 This section was renamed to be more descriptive.

DIVISION 7 CONCRETE PAVEMENTS AND SHOULDERS

700-1 The second paragraph of this section was revised to include ride quality as a characteristic in which the Department accepts concrete paving.

A paragraph was added to require the contractor to submit a Process Control Plan.

700-3 This article was revised in its entirety to give better instruction concerning the concrete hauling equipment procedures.

700-4 Exercise extreme care to ensure that no free water or ponding is present at the time of concrete placement.

Hauling over the underlying asphalt courses will not be allowed other than necessary local traffic and that developing from the operation of essential construction equipment as may be authorized by the Engineer.

A paragraph was added to require the contractor to use a cable stringline reference to use to control the profile and alignment of the concrete pavement.

700-5 The Section number 1412 was revised to 1413 to reflect a numbering change in Division 10.

The air temperature, in which concrete paving is to be stopped, was changed from 40°F to 35°F on the lower end and from 95°F to 90°F on the upper end.

The 6^{th} and 7th paragraphs in section (A) were revised to allow the use of the maturity meter in determining the strength of the concrete in order to allow construction equipment or hauling equipment on the pavement.

The last paragraph in Section (A) was moved from Section (B) for cohesion purposes.

In Section (B), revisions were made to provide cohesion to the section. Also, some sentences where deleted because they were redundant.

700-6 The article revised in its entirety to concentrate solely on vibrating concrete. Additional instructions were added concerning the requirement of an electronic vibrator monitoring device.

700-8 The article was revised in its entirety to give better instruction on how the Department requires the PCCP to be protected from weather conditions.

700-9 In Section (A), a change was made to require the use of a curing period of 7 curing days for pozzolan mix designs.

Section (B) was revised to detail when the curing compound should be applied, when hand spraying shall be permitted, and to instruct the use of an inline flow metering device to ensure the proper application rate. The last paragraph in this section was added to instruct that the pavement be re-sprayed if it were subject to heavy rainfall within 3 hours after the curing compound had been applied.

Section (C) was revised to provide further instruction on curing concrete with the use of polyethylene film.

700-11 Section (A) was revised to incorporate the project special provision that requires sawing and sealing of all transverse joints. The sawing shall be done with an early entry dry-cutting sawing system.

700-12 Section (A) was revised to incorporate the project special provision that requires the sealing of all joints with rubber asphalt joint sealer instead of a backer rod and low modulus sealant.

The last sentence was added in section (D) to specify that no overbanding of filler material would be allowed.

700-13 The article was revised to incorporate the project special provision that allows the use of the maturity method for early opening of concrete pavement to construction traffic.

700-15 Section (E) was revised to specify that the flexural strength of concrete will determined by testing a minimum of one set of two 6" x 6" x 20" beams at 28 calendar days instead of 14 calendar days.

The second paragraph in Section (F) was revised to allow the contractor to use either test beams or the maturity method to determine that the concrete has attained a flexural strength of at least 450 psi.

710-1 The article was revised to include performing maturity testing as work covered by this section.

710-4 In the second paragraph, 14 calendar days was changed to 28 calendar days.

710-7 The 6th paragraph of this article was revised to specify that the concrete pavement surface have a profile index (PI) along any line tested not exceeding 25 inches per mile, as determined with a 0.00 inch blanking band, over any 600 foot section of pavement.

Also a sentence was added to instruct the contractor to verify that the corrective measures performed have obtained the smoothness requirements.

710-10 Section (C) was revised to reflect the change of the flexural strength requirement from 600 psi at 14 days to 650 psi at 28 days. In addition, any pavement that fails to attain 600 psi, instead of 550 psi, is subject to removal.

720-1 The article was revised to include furnishing maturity testing equipment as work covered by this section.

DIVISION 8 INCIDENTALS

801-1 Added language concerning stake out of permitted work areas

846 Deleted Modified Concrete Flume.

848 Concrete Wheelchair Ramps pay item changed to each.

848 Incorporated Detectable Warning from Project Special Provision

852 Removed Corrugated Concrete Island

855 Deleted Precast Concrete Noise Barrier.

860 Deleted Temporary Concrete Cover for Catch Basins.

862-3 Revised language concerning rock interfering with post installation.

864 Added Remove and Reset Guiderail

876 Removed Concrete Riprap

DIVISION 9 SIGNING

900-2 Deleted old Subarticle, Applicable Specifications, Standards, and Publications.

901-3(B) Added storage fee of 5% of the cost of the sign per month or portion thereof.

901-3(D) Reworded to add verbiage on the application of chromate conversion coating and to remove Cleaning and Etching.

901-3(F) Removed reference to use AWS certified welders.

901-3(H)(3) Removed verbiage on demountable button type letters, numerals, symbols, and borders.
901-3(L) Added new Subarticle on Transparent Films.
901-4(E) Deleted Subarticle Close up Inspection and replaced with new Silk Screening Inspection Procedures.
902 Changed title to FOUNDATIONS FOR GROUND MOUNTED SIGNS
902-3(C) Deleted Subarticle Overhead. If needed, it will be used as a project special provision.
903 Changed title to GROUND MOUNTED SIGN SUPPORTS
903-3(A) Reworded.
903-3(C) Deleted Subarticle Overhead Sign Supports. If needed, it will be used as a project special provision.
903-3(D) Added verbiage on island applications and organic non-aerosol zinc repair paint
903-3(F) Added verbiage.
903-3(G) Added new Subarticle Steel Square Tube Supports.
904-3(H) Added new Subarticle Relocation (Ground Mounted) Signs.
905 Deleted. If needed, it will be used as a project special provision.
906 Deleted
908 Deleted.

DIVISION 10 MATERIALS

1000-2 Added Silica fume.
1000-2 Added Calcium nitrite corrosion inhibitor.
1000-3 Changed minimum flexural strength of concrete pavement to 650 psi.
1000-3(A) Added reference to Form 312U.
1000-3(A) Deleted text referencing changes to mix proportions.
Table 1000-1 Added several concrete mix types.
1000-5 Deleted Class M specification.
1000-5-1000-11 Renumbered to accommodate flowable fill and latex modified concrete sections.
1000-7 Added specification for flowable fill.
1000-8 Added specification for latex modified concrete.
Table 1005-2 Updated 2s and 2ms gradations.
1006-1 Added verbiage describing sections of the Aggregate QC/QA manual.
1006-2(F) Added Plant Ownership Update Form requirement.
1008-1(E) Deleted reference to NCDOT Assurance Sampling at a Stockpile.
Table 1010-1 Deleted reference to aggregate base course types and updated passing #200 gradation requirements and related notes.
1010-2 (A) Changed price adjustment verbiage.
1010-2 (B) Deleted reference to Type B aggregate base course.
1010-4(B) Changed lot size.
1014-2(E)(1) Added No. 78M aggregate.
1014-2(E)(2) Deleted Machine Placed Curb, Curb and Gutter and Paved Ditch.
Added Latex Modified Concrete specification.
1014-2(E)(6) Added Sand Lightweight Concrete specification.
1018-2(B)(2) Deleted reference to overburden from quarries.
1020-2 Changed reference from AASHTO MP-1 to AASHTO M 320.

1020-7	Added requirement to AASHTO T59. Added exceptions for CRS-2P emulsions.
1020-9(C)	Deleted reference to Cut-Back Asphalt.
1024-3(D)(5)	Added reference to Corrosion Inhibitor.
1050-3	Added color and thickness verbiage.
1050-4	Changed requirements for barbed wire.
1050-5	Changed woven wire strength requirement.
1050-6	Added verbiage on color requirement.
1050-8	Prohibits use of aerosol products.
1056	Changed test methods required.
1060-3	Deleted geographic limitations on limestone.
1060-13	Added license requirement for herbicide application.
1070-10	Added Mechanical Butt Splice requirements.
1072-7(B)(2)	Specified requirement of coating nuts with wax lubricant.
1072-9(D)	Specified Charpy V-notch test requirement for diaphragms and crossframes connecting horizontally curved members.
1072-12(E)	Added section for Heat Curving Girders Renumbered to (G) to accommodate Heat Curving Girders.
1074-7(B)	Added requirement to mark castings.
1078-2	Added reference to Epoxy Protective Coating.
1078-3	Added requirement to provide separate internet access in office area.
1078-5	Added requirements for casting holes.
1078-9	Added verbiage concerning box beams and allowance for use of self consolidating concrete
1078-12	Added section on Vertical Cracks in Prestressed Girders Prior To Detensioning.
1078-12-1078-17	Renumbered to accommodate section on Vertical Cracks in Prestressed Girders Prior To Detensioning.
1078-13(E)	Specifies requirements for conduit, and prohibits use of flexible conduit.
1078-14	Changed allowable stress allowance during handling.
1078-15	Added requirements for top surface, void repair, and coating ends of prestressed members.
1078-16(F)	Added section on Box Beams.
1080-4	Added testing requirements.
1080-12	Added SSPC requirements.
1082-1	Added General section.
1082-1-1082-3	Renumbered to accommodate General section.
1082-2(C)	Deleted reference to Sheet Piles
1082-3(F)	Added requirements for poles.
1082-4(G)	Added requirements for poles.
1084	Deleted references to untreated timber piles.
1084-1(B)	Added grade requirements for steel piles.
1084-2(A)	Added requirements for treated timber sheet piles.
1084-2(C)	Added requirements for prestressed concrete sheet piles.
Table 1092-1	Modified references to alloys.
1092-3	Deleted section on Button-Type Demountable Copy.
1092-3-1092-4	Renumbered to accommodate deletion of section.
1092-3	Changed certification to Type 6.
1093-1	Added requirement of encapsulated or enclosed lens.

1093-2(A)(2) Deleted requirement for performance bonding.
1093 Tables Deleted Type II. Modified Type IV, V, VI, VII, VIII, IX requirements. Added Type X requirements.
1093-2(E) Deleted and modified several performance requirements.
1094-1(D) Added Steel Square Tube Posts.
1094-1(E) Added Wood Supports.
1096-2 Added requirement for mechanical galvanization of all fasteners.
1097-7 Reference is made to 1082 for treatment of poles.
1098-1 Revised QPL approval to date of installation, from existing project special provision.
Deleted Plan Quantity Measurements.
Revised plan of record documentation requirements.
Added fiber-optic lashing wire requirement to Wire & Cable, from existing project special provision.
Moved Electrical Service from other section.
Old 1098-2 Deleted Signal Heads
1098-4 New subarticle, from project special provision and other sections.
1098-5 Revised general requirements.
Deleted oversized junction boxes.
Revised requirements for standard and oversize heavy-duty junction boxes.
1098-7 Added option to use double-strand eyes, from existing project special provision.
1**098-9** Revised loop lead-in cable, from existing project special provision.
Added requirement to provide length markings.
Old 1098-10 Deleted Loop Emulator
1098-12 Added Self-Healing Ring Transceivers, from existing project special provision.
Old 1098-15 Deleted Metal Poles
Old 1098-16 Deleted Mast Arms
1098-14 Revised anchor bolt length. Deleted tapered shafts.
1098-15 New subarticle from other section.
1098-16 Added Cabinet Base Adapter/Extender, from existing project special provision.
1098-17 Added Beacon Controller Assemblies, from existing project special provision.
Old 1098-18-22 Deleted Cabinets and Controllers
Old 1098-23 Deleted Closed Loop System

DIVISION 11 WORK ZONE TRAFFIC CONTROL

1101-5(D) Deleted
1101-35 Deleted Maintenance of the Travelway
1101-8 Redefined parking of personal vehicles on DOT right of way
1105-4 Renamed Maintenance and Inspection. Major rewording of this article.
1105-6 Deleted Construction Zone Traffic Control Device Surveillance
1110-3(C) Major rewording
1120-5 Added NEW pay item: Changeable Message Sign (Short Term). This pay item is paid per day for Short Term CMS used on a project for a specific work operation, removed from the project after the specific work operation is completed, and remains on the project NO MORE than 1 month.
1125 Deleted Warning Flag Sets. If needed, it will be used as a special provision.

1145 Deleted Type II Barricades. Only allow Type III Barricades.

1150-4 All Flaggers, including ones used on -Y- lines, will be paid for if they are used in conjunction with a lane closure. All other flaggers (i.e. for entrance to borrow pit, for trucks crossing a road, etc.) will be incidental.

1155 Deleted Warning Lights. Will be used as a special provision if necessary.

1165 TMIAs used in Moving and Mobile operations will be incidental to the work being performed. No payment will be made for TMIAs used in Moving and Mobile operations.

1175 Deleted Temporary Shoring for the Maintenance of Traffic, will be a special provision if needed.

1180 Skinny Drums, New section

DIVISION 12 PAVEMENT MARKINGS, MARKERS AND DELINEATION

1205 Rearranged the section to include separate Articles for Paint, Thermoplastic, Polyurea, Epoxy, Cold Applied Plastic, and Heated In Place Thermoplastic.
Added the special provision for Polyurea Pavement Markings to this section.
Added 4 categories under Cold Applied Plastic with minimum retroreflective values for each:

- Category 1: Permanent Standard Tape
- Category 2: Permanent High Performance Tape
- Category 3: Permanent Wet Reflective High Performance Tape
- Category 4: Removable Tape

Added minimum retroreflective readings for polyurea markings that have been snowplowed during the 180-day observation period.

1251 Raised Pavement Markers, combined Temporary and Permanent Raised Markers and changed the title.

1252 Deleted Permanent Raised Pavement Markers. Permanent Raised Markers have been included in Section 1251 – Raised Pavement Markers.

1265 Deleted Drum Type Delineators. This item is not used anymore.

DIVISION 14 LIGHTING

1400-2(B) Included High Density Polyethylene (HDPE) conduit.

1400-4(I) Replaced grout at base of High Mount Standards with galvanized hardware cloth.

1401 Added requirements for design based on Fatigue Calculations, with Magnetic Particle Testing (MPT) for base to upright welds.

1402-3 Updated foundation design based on 2001 AASHTO requirements and new Standard Drawing.

1403-2 Added requirement for Cutoff optics and glare shields.

1406-2 Added requirement for third party certification of photometric data upon request.

1408-2 Added requirement for load-side multi-tap box lugs or distribution blocks for service breaker. Added requirement for mounting brackets or screw studs for mounting components. Added requirement for labeling per NEC.

1409-2 Included High Density Polyethylene (HDPE) duct. Added clear zone requirements for bore pits.

1410-2 Included High Density Polyethylene (HDPE) conduit.

1413-5 Added minimum and maximum spacing for tower lights.

DIVISION 15 UTILITY CONSTRUCTION

Changed name from Utilities to UTILITY CONSTRUCTION

1500-1 Condensed wording

1500-2 Added verbiage about agreements with utility owner and communications.

1500-3 Added paragraph about final connections.

1500-4 Removed paragraph about adjusting other utilities since this is covered in Div. 1.

1500-5 Corrected language by removing sanitary.

1500-6 Reworded for clarity.

1500-7 New Article incorporating requirements from other sections into this section and requiring As-Built plans.

1500-8 New Article incorporating requirements from other sections into this section.

1500-9 New Article incorporating requirements from other sections into this section.

1500-10 Changed name and condensed language.

1505 Added Pipe Laying to title.
Changed pay items.

1505-1 Condensed wording

1505-2 Specified class of select material.

1505-3 Reworded.

(A) Added Sub-Article

(B) Added Sub-Article

(C) Added Sub-Article

(D) Added Sub-Article

(E) Added Sub-Article

(F) Added Sub-Article

1505-4 Reworded.

1505-5 Minor word changes

1505-6 Added pipe laying, bedding, and thrust restraint as incidental.

(A) Reworded.

(B) Added to bedding material as incidental.

(C) Minor wording change.

(D) Minor wording change.

(E) Minor wording change.

Eliminated 3 pay items. Foundation conditioning material, Select Backfill, and Pavement Repair will no longer be separated under a Utilities category. Use pay items elsewhere in *Standard Specifications.*

1510 Title change.
Extensive changes to overall document. Moved utility controls to Section 1515. Moved some requirements to Section 1500. Reduced pay item to only water pipe without separate payment for various types, fittings, or appurtenances. Eliminated payment for service lines.

1510-1 Condensed wording.

1510-2 Added Contractor selection to piping material type.
Added provisions for locator wires and marking tape.
Moved submittal requirements to Section 1500.

1510-3	Extensively reworded and updated.
1510-3(A)	Testing and Sterilization Reworded and updated. Added pigging requirement. Testing, cleaning and sterilization may be performed concurrently or consecutively. Dispose of waste water in accordance with all environmental regulations.
1510-4	Condensed Measurement and Payment to one Article. Eliminated or moved pay items to other Sections.
1515	New Section. Pay items for valves, hydrants, meters, etc.
1520	Title change. Extensive changes to overall document. Moved utility controls to Section 1515. Moved some requirements to Section 1500. Reduced pay item to only sewer pipe without separate payment for various types, fittings, or appurtenances. Eliminated payment for service lines.
1520-1	Condensed wording.
1520-2	Added Contractor selection to piping material type. Added provisions for locator wires and marking tape. Moved submittal requirements to Section 1500.
1520-3	Extensively reworded and updated. Required conformance with DENR requirements. Added pumping requirements. Added deflection testing and lamping test.
1520-4	Condensed Measurement and Payment to one Article. Eliminated or moved pay items to other Sections.
1525	Title Change. Included water manholes under generic title Utility Manhole and condensed pay items. Reworded and condensed.
1525-2	Added more detail.
1525-3	Added manhole top height requirements and adjustment requirements. Added vacuum test.
1525-4	Eliminated drop assemblies.
1530	Title Change. Renamed pay items and included items from other sections.
1530-1	Reworded and condensed.
1530-2	Condensed.
1530-3	Apply all the requirements in Section 1505 for excavation, trenching, pipe laying, and backfill.
1530-3(A)	Abandoning Pipe: Reworded and added additional criteria.
1530-4	Renamed pay items, added pay items from other sections.
1540	Expanded criteria and renamed pay items.
1540-1	Condensed.
1540-2	Added more materials.
1540-3	Moved trenchless to Section 1550. Added fill requirement to large casings.

1540-4	Renamed pay item.
1550	New Section Pay items as additional compensation for trenchless construction.

DIVISION 16 EROSION CONTROL AND ROADSIDE DEVELOPMENT

1635-3(A) and (B)	Rewrite
1636	Deleted
1638	Stilling Basins Rewrite
1663	Deleted Sprigging
1675	Deleted Response for Erosion Control (revised and made Project Special Provision.)

DIVISION 17 – SIGNALS AND INTELLIGENT TRANSPORTATION SYSTEMS

1700-3	Clarified who is responsible for utility charges. Added liquidated damage, from existing project special provision. Added new subarticles: Inspections and Traffic Signal Activation. Added option to splice wires in condulets. Moved Grounding from other section. Added new subarticles Electrical Bonding and Temporary Traffic Signal Installation, from existing project special provisions.
1705-1	Deleted incandescent sections.
1705-2	Revised to refer to project special provisions.
1705-3	Clarified bagging signal heads, splicing. Deleted requirement for maximum of 6 heads on one neutral conductor. Removed reference to MUTCD for height of pedestrian heads.
1705-4	Revised signal cable pay item to actual linear feet.
1710-3	Clarified bonding requirements. Revise to 27’ over railroad tracks, from existing project special provision.
1710-4	Revised pay item to actual linear feet.
1715	Expanded section to include Directional Drill and Plowing, from existing project special provision
1715-4	Revised pay items to pay for size and quantities of conduit for Trenching and Bore and Jack.
1716-3	Removed requirement to install junction boxes every 250 feet.
1720-2	Revised to refer to 1082 for materials. Clarified grounding requirements.
1721-3	Clarified guy assemblies required for type of cable installed. Changed strand vise to three-bolt clamp.
1722-3	Added requirement for condulet for lead-in cable, from existing project special provision.
1722-4	Added pay item for Heat Shrink Tubing Retrofit Kit.
1725-3	Added requirement that all work must be performed in the presence of the engineer, from existing project special provision. Added requirement to submit Inductive Detection Loop & Grounding Tests Results form.

1726-3	Removed type 1 and type 2 lead-in cable, from existing project special provision. Revised loop system resistance, from existing project special provision.
1726-4	Revised pay item to actual linear feet, either 18-2 pair or 18-4 pair lead-in cable.
1727	Deleted Video Loop Emulator Detection
1731-2	Revised to require material to be on QPL.
1732-4	Revised testing requirements.
1732-2	Revised to require material to be on QPL.
1732-4	Added pay item for Fiber-Optic Self-Healing Ring Transceiver.
1734	Added Remove Existing Communication Cable, from existing project special provision.
1735	Added Cable Transfers, from existing project special provision.
1740	Deleted Metal Strain Poles
1741	Deleted Mast Arms with Metal Poles
1742	Deleted Metal Pole Foundations
1743-2	Clarified that concrete requirement is Class B.
1743-3	Revised to no longer caulk foundations and base plate, from existing project special provision. Removed requirements to submit shop drawings.
1743	Deleted Structure Design of Signal Supports
1750-1	Revised Selection of foundation type revised to by the Engineer.
1751-2	To refer to contract
1752	Deleted Closed Loop System Master Controller
1753	Added Cabinet Base Adapter/Extender, from existing project special provision.
1755	Added Beacon Controller Assemblies

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STANDARD SPECIAL PROVISION

ERRATA

(7-15-08) Z-4

Revise the *Standard Specifications for Roads and Structures July 2006* on all projects as follows:

Division 1

- Page 1-1, replace AREA - American Railway Engineering Association with ***American Railway Engineering and Maintenance of Way Association*.**
- Page 1-7, remove **–L-** in middle of page after INVITATION TO BID and before LABORATORY.
- Page 1-25, 102-16(R), move 2nd paragraph to left margin. It is not a part of this subarticle, but part of the entire article.

Division 2

- Page 2-9, Subarticle 225-1(C), 1st paragraph, 2nd line, last word, add a "d" to make the word grade become ***graded***.
- Page 2-15, Subarticle 226-3, 5th paragraph, first line, replace the word *in* with the word ***is***.
- Page 2-23, Subarticle 235-4(B)(9), at the end of the sentence, replace finished greater with finished ***grade***.
- Page 2-28, Article 260-3, First paragraph, second line, remove the word *foot*.

Division 3

- Page 3-13, Article 340-4, Second paragraph, change Flowable Backfill to Flowable ***Fill***

Division 4

- Page 4-70, 442-13(B) Second sentence, change SSPC Guide 6I to SSPC Guide ***6.***
- Pages 4-72, 4-74, 4-76, at the top of the page, substitute the heading Section 452 with Section ***450*.**
- Page 4-79, at the top of the page, substitute the heading Section 450 with Section ***452***
- Page 4-80, change 452-7 to 452-***6*** at the top of the page.
- Page 4-80, change Pay Item ___Steel Pile Retaining Walls, to ***Sheet*** Pile Retaining Walls.
- Page 4-88, 462-4, Title, Replace last word Measurement with the word ***PAYMENT***

Division 5

- Page 5-8, Article 501-15 Measurement and Payment, delete the 4th paragraph that begins The quantity of lime, measured as provided …

Division 6

- Page 6-3, Article 600-9, 2nd Paragraph on this page, replace 818-5 with 818-***4***.

- Pages 6-30 and 31, Subarticle 610-3(A)(13) Move 2 paragraphs from the margin to the right under the number (13).
- Page 6-43, Article 610-8, 4th paragraph, remove the first ***the***
- Page 6-44, 2nd full paragraph, 1st sentence, delete the first ***and*** and add ***transverse*** just before cross-slope control.
- Page 6-51, at the top of the page, add ***610-14*** on the same line, and just before the heading MAINTENANCE.
- Page 6-53, Article 620-4 sixth paragraph, second line; the word that should be ***which***.
- Page 6-66, title, Replace EXISTNG with **EXISTING**
- Page 6-66, Article 657-1, Description, first sentence, replace PS/AR (hot-poured rubber asphalt with ***hot applied joint sealer***.
- Page 6-66, Article 657-2, replace PS/AR (Hot-Poured Rubber Asphalt with the following:

Item	Section
Hot Applied Joint Sealer	***1028-2***

- Page 6-67, at the top of the page, substitute the heading Section 654 with Section ***657.***
- Page 6-67, Article 657-3 Construction Methods, 2nd paragraph, replace PS/AR sealant with ***hot applied joint sealer***.
- Page 6-71, 660-9(B)(1), Replace the first sentence of the first paragraph with the following:

  Using the quantities shown in *Table 660-1*, apply asphalt material to the existing surface followed by an application of No. 78 M or lightweight aggregate.

- Page 6-89; Add a period at the end of the last sentence at the bottom of the page.
- Page 6-90, Article 663-5, first paragraph, first sentence, change 50oF to ***50^oF;*** third paragraph, fourth sentence change 325oF to ***325^oF.***

Division 7

- Page 7-12, at the top of the page, substitute the heading Section 710 with Section ***700***.
- Page 7-15, Article 710-9, 4th paragraph, last line, change 710-11(B) to 710-1***0***(B).

Division 8

- Page 8-13, Article 808-3, 4th Paragraph, third line, replace Eexcavation with ***Excavation***
- Page 8-35, Article 848-2, Item: Replace Cncrete with ***Concrete***

Division 9

- Page 9-2, add ***901-3*** just before CONSTRUCTION METHODS

Division 10

- Page 10-12, near bottom of page add ***(C)*** before Proportioning and Mixing of Modified Compositions, which should be bold type.
- Page 10-28, at the top of the page, substitute Section 100***6*** for 1005.
- Page 10-54, Subarticle 1018-2A), First line, substitute ***(B)*** for II, third line, substitute ***(B)(2)*** for II-b.
- Pages 10-56, 10-58, 10-60 at the top of the page, substitute Section 1018 with Section ***1020.***
- Page 10-84, Table 1042-1, Class 2, Maximum, change from 23r to ***23***.
- Page 10-84, Article 1042-2 Testing, last sentence, replace the word alterations with the word ***cycles***.
- Page 10-100, Table 1056-1, replace on the line for Trapezoidal Tear Strength:

Type 1	Type 2	Type 3		Type 4
		Class A	Class B	Soil Stabilization
45 lb	***75*** lb	--	--	***75*** lb

- Page 10-116, Subarticle 1070-10, first paragraph, second sentence, add ***or*** just before cold-forged sleeve.
- Pages 10-136 through 10-147, at the top of the page, substitute Section 1074 with Section ***1072***.
- Page 10-157, Article 1077-11, first paragraph, change the reference from Subarticle 420-18(B) to Subarticle 420-***17***(B).
- Page 10-211, at the top of the page, substitute Section 1081 with Section ***1082.***
- Page 10-229, add ***1088-6 BLANK*** on the line above 1088-7 TUBULAR MARKERS.
- Page 10-244, add **1089-10** ***BLANK*** and **1089-11** ***BLANK*** on the lines just above 1089-12 FLAGGER.
- Page 10-272, delete Article 1098-6 in its entirety. Renumber Articles 1098-7 through 1098-17 as Articles 1098-6 through 1098-16 consecutively.

Division 12

- Page 12-21 Add ***1266-2*** just before the heading MATERIALS.

Division 15

- Page 15-2 add ***1500-4*** just before the heading WEEKEND, NIGHT AND HOLIDAY WORK.
- Page 15-4, Subarticle 1505-3(A)(2), replace the 2nd line with the following: ***Provide shielding or shoring as required under Section 150 or as required elsewhere in the contract.***

- Page 15-5, add ***1505-6*** on the same line and just before the heading MEASUREMENT AND PAYMENT. (Remove the period after PAYMENT.)
- Page 15-6, Article 1505-6(3), delete *in Section 1175* and replace it with *elsewhere in the contract*.
- Page 15-8, add **1510-4** on the same line and just before the heading MEASUREMENT AND PAYMENT.
- Page 15-10, substitute **BLANK** for CONSTRUCTION REQUIREMENTS on the same line and just before 1515-4.
- Page 15-10, substitute **CONSTRUCTION REQUIREMENTS** for General Requirements
- Page 15-10, Article 1515-4, add ***(D)*** just before the bolded Fire Hydrants.
- Page 15-13, Article 1520-3, 8th paragraph, add ***pipe*** after diameter.
- Page 15-22, add ***1540-3*** on the same line and just before the heading CONSTRUCTION REQUIREMENTS.
- Page 15-28, Replace 1550-6 METHOD OF MEASUREMENT with ***MEASUREMENT AND PAYMENT.***

Division 16

- Page 16-12, Subarticle 1632-1(C) ¼ Inch hardware cloth, change the minimum width from 24 inches to 48 inches.

Division 17

- Page 17-19, Subarticle 1725-2 Material, Second paragraph, change Article 1098-7 to 1098-***8***
- Page 17-20, Subarticle 1726-2 Material, Second paragraph, change Article 1098-8 to 1098-**9**

END