

**MISSISSIPPI
STANDARD SPECIFICATIONS
FOR
ROAD AND BRIDGE
CONSTRUCTION**



**MISSISSIPPI
DEPARTMENT OF TRANSPORTATION
JACKSON**

2004 EDITION

**Mississippi
Standard Specifications
For
Road And Bridge
Construction**

No. _____



**Approved and Adopted
By**

**The Mississippi
Transportation Commission
Jackson**

February 24, 2004

STANDARD SPECIFICATIONS

2004 EDITION

The Standard Specifications for road and bridge construction in Mississippi have been prepared, examined and recommended in the manner and form set out in a book entitled "Mississippi Standard Specifications for Road and Bridge Construction"--"Mississippi Department of Transportation, Jackson"--"2004 Edition", and a copy has been filed in the office of the Secretary of the Mississippi Transportation Commission. It is hereby ordered that such specifications are approved and adopted as of this date for all road and bridge construction except as may be designated otherwise in the contract documents for work already advertised or under construction.

Ordered this the 24th day of February, 2004.

* * * * *

STATE OF MISSISSIPPI

COUNTY OF HINDS

I, Linda Ferrell, Secretary, Mississippi Transportation Commission, State of Mississippi, do hereby certify that the above is a true and correct copy of an order duly passed by the said Mississippi Transportation Commission at its meeting held on the 24th day of February, 2004.

Given under my hand and seal of office, this the 24th day of February, 2004.

A handwritten signature in cursive script that reads "Linda O. Ferrell". The signature is written in dark ink and is positioned above a horizontal line.

Secretary, Mississippi Transportation
Commission, State of Mississippi

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Section

DIVISION 900 - CONTRACT DOCUMENTARY FORMS
(Under Separate Cover)

- 901 Advertisement
- 902 Contract
- 903 Contract Bond
- 904 Notice to Bidders (NTB)
- 905 Proposal
- 906 Required Contract Provisions (Form FHWA-1273, FHWA-1273A, etc.)
- 907 Special Provisions (SP) and Interim Specifications (IS)
- 908 Supplemental Specifications

DIVISION 100 - GENERAL PROVISIONS

It is understood and agreed that all of the provisions and requirements of DIVISION 100 shall be applicable to all contracts.

It is further understood and agreed that the requirements of Figure 1 at the end of Section 101 shall be applicable to all contracts on which the typical section(s) of the plans show construction of any element of the pavement structure or shoulder(s).

SECTION 101 - DEFINITIONS AND TERMS

Whenever terms not defined herein are used to identify geometric elements of the work, such terms shall be understood to have the meaning as established by the American Association of State Highway and Transportation Officials in the book entitled "AASHTO Highway Definitions" which is current at the time bids are received.

Where the following abbreviations and definitions are used in these specifications or other contract documents, they are to be construed the same as the respective expression.

101.01--Abbreviations.

AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway Transportation Officials
ACI	American Concrete Institute
AGC	Associated General Contractors of America
AIA	American Institute of Architects
AIEE	American Institute of Electrical Engineers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ANSI	American National Standards Institute
AOAC	Association of Official Analytical Chemists
API	American Petroleum Institute
APWA	American Public Works Association
ARA	American Railway Association
ARBA	American Road Builders Association
AREA	American Railway Engineering Association
ARTBA	American Road and Transportation Builders Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials

AVTU	Average Value per Time Unit
AWG	American Wire Gage
AWPA	American Wood Preservers Association
AWS	American Welding Society
AWWA	American Water Works Association
Code(NEC)	National Electrical Code
CRSI	Concrete Reinforcing Steel Institute
CS	Commercial Standards, U. S. Department of Commerce
CSPI	Corrugated Steel Pipe Institute
EIA	Electronic Industries Association
EPA	Environmental Protection Agency
ESFE	Estimated State Furnished Excavation
FCP	Fixed Contract Unit Price
FHWA	Federal Highway Administration
FM	Final Measure
FME	Final Measure - Embankment
FSS	Federal Specifications and Standards (General Services Administration)
HRB	Highway Research Board
Hz	Hertz
ICEA	Insulated Cable Engineers Association
ID	Inside Diameter
IES	Illuminating Engineering Society
IMSA	International Municipal Signal Association
IPS	Interior Pipe Size
IS	Interim Specifications
ITE	Institute of Transportation Engineers
LVM	Loose Vehicular Measure
MAPA	Mississippi Asphalt Pavement Association
MDOT	Mississippi Department of Transportation
MIL	Military Specifications
MSG	Manufacturers Standard Gauge
MUTCD	Manual on Uniform Traffic Control Devices
NACE	National Association of Corrosion Engineers
NAPA	National Asphalt Pavement Association
NBC	National Building Code
NBS	U.S. National Bureau of Standards
NCHRP	National Cooperative Highway Research Program
NEC(Code)	National Electric Code
NEMA	National Electrical Manufacturers Association
NPC	National Plumbing Code
NSF	National Sanitation Foundation
NTB	Notice To Bidders
OD	Outside Diameter
OSHA	Occupational Safety and Health Administration
PCI	Prestressed Concrete Institute

RCRA	Resource Conservation and Recovery Act
RAP	Recycled Asphalt Pavement
SAE	Society of Automotive Engineers
SAVE	Society of American Value Engineering
SOP	The MDOT's Standard Operating Procedures
SP	Special Provisions
SS	Supplemental Specifications
SSPC	Steel Structures Painting Council
TRB	Transportation Research Board
UL	Underwriters Laboratories, Inc.
UNC	Upset National Coarse Threaded Bolts
UST	Underground Storage Tank

101.02--Definitions.

Additive - A substance or agent added in small amounts to a basic ingredient of a mixture prior to mixing.

Admixture - A substance or agent added in small amounts to the basic ingredients of a mixture during the mixing process.

Advertisement - The public announcement, as required by law, inviting bids for work to be performed or materials to be furnished.

Alternate Designs - Alternate designs of construction or construction and materials designated in the bid schedule of the proposal as Alternate Designs which must be pre-selected by the Contractor and indicated on the bid. Alternate Designs may contain Alternate or Optional Items.

Alternate Items - Alternate pay items of work, or materials and work designated in the bid schedule of the proposal as Alternate Items, with separate pay item numbers, and which must be pre-selected by the Contractor and indicated on the Contractor's bid.

Average Value per Time Unit (AVTU) - The computed average dollar value per time unit for each work phase, computed as being the contract dollar value of the work phase, divided by the number of time units designated for that phase by the length of the bar as set forth in the approved progress schedule.

Award - The acceptance by the Mississippi Transportation Commission of a proposal.

Base Course - The layer or layers of specified or selected material of designed thickness placed on a subgrade to support a pavement.

Basement Soils - That portion of the roadway in embankment areas below the

design soil and to the bottom of the embankment or undercut, whichever is lower, and that portion of the earthwork in cut areas below the design soil and to the bottom of any undercut or other treatment required, whichever is lower.

Bidder - An individual, partnership, firm or corporation formally submitting a proposal for the advertised work or materials.

Borrow - Suitable material from approved sources outside the roadway prism, used primarily for embankments.

Box Bridge - A box culvert having a clear distance between inside face of the end supports exceeding 20 feet measured along the centerline of the roadway.

Bridge - A structure, including supports, erected over a depression or an obstruction, as water, highway, or railway, and having a track or passageway 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 abutments or extreme ends of openings for multiple boxes.

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; but in no case less than the total clear opening of the structure.

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

Bridge Site - Unless otherwise specified in the contract, the bridge site shall be the entire area between the right-of-way lines and between lines paralleling the bridge ends and passing through the longitudinal extremities of the substructure or superstructure, whichever is greater.

Calendar Day - Any day shown on the calendar, beginning and ending at midnight.

Commission - The Mississippi Transportation Commission.

Conformity - The degree of perfection required for the materials furnished and the work performed, and determined:

- (a) In the case of a required "minimum" or "maximum" value of a measurable characteristic, as set out in Subsection 700.04.
- (b) In the case of a required non-measurable characteristic, as being

satisfactory to the Engineer.

Contract - The written agreement between the Mississippi Transportation Commission and the Contractor setting forth the obligations of the parties thereunder, including but not limited to, the performance of the work, the furnishing of labor and materials, and the basis of payment.

The contract includes the invitation for bids, proposal, contract form and contract bond, specifications, supplemental specifications, interim specifications, general and detailed plans, special provisions, notices to bidders, notice to proceed, and also any agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions thereof, all of which constitute one instrument.

Contract Bond - The approved form of security, executed by the Contractor and the Contractor's Surety, guaranteeing complete execution of the contract and all supplemental agreements pertaining thereto and the payment of all legal debts pertaining to the construction of the project.

Contract Documents - All original or official papers relied upon as the basis, proof or support of the contract and shall include those papers stated in the definition of Contract.

Contract Item (Pay Item) - A specifically described unit of work for which a price is provided in the contract.

Contract Time - The period of time, including authorized extensions, allowed for completion of work under the contract.

Contract Unit Price - The price provided for in the contract for a specifically described unit of work.

Contractor - The individual, partnership, firm or corporation contracting with the Department for performance of prescribed work.

Control of Access - The condition where the right of owners or occupants of abutting land or other persons to access, light, air, or view in connection with a highway is fully or partially controlled by public authority.

Controlling Work - The work or construction operations normally expected to be in progress as determined by the Engineer after careful consideration of the approved progress schedule.

County - The county in which the work is to be done.

Cross Slope - The rate of transverse slope in a roadbed element.

Culvert - Any structure not classified as a bridge which provides an opening under the roadway.

Department's Standard Operating Procedures - The Department's Standard Operating Procedures are the rules, regulations, instructions and policies, promulgated by the Commission acting through the Executive Director or authorized representative and on file in the Central Records Section of the Support Services Division.

Department - The Mississippi Department of Transportation.

Dependent Pay Items - Those pay items such as maintenance of traffic, mobilization, and construction stakes for which the amount of payment allowed on progress estimates may be based on the amount earned on other pay items.

Design Grade - Design grade is an intermediate control grade at a vertical distance, as established on the typical section of the plans for the various intermediate courses, below profile grade.

Design Soil - That portion of the roadbed consisting of the top three feet of untreated or treated soils in excavated sections and embankments.

Direct Pay Items - Those pay items for which payment is based on the quantity of the item completed.

Documentation - Written evidence recorded by an authorized individual or employee of either party to the contract of facts or conditions relating to a particular contractual matter.

Elements of Geometric Design - Those geometric elements of the highway as are defined in the "AASHTO Policy on Geometric Design" in effect at the time bids are received.

Engineer - The Chief Engineer of the Department, acting directly or through a duly authorized representative(s), who is responsible for engineering supervision of the construction.

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

Executive Director - The Executive Director of the Mississippi Department of Transportation acting directly or through authorized representatives.

Extra Work - An item of work not provided for in the contract as awarded, or an item of work provided for in the contract the nature or character of which is

changed by the Engineer such as to justify a price adjustment, either of which is found by the Department to be essential to the satisfactory completion of the contract within its intended scope.

Fixed Contract Unit Price - When the bid schedule of the proposal form indicates a fixed contract unit price (FCP), this price shall become the contract price for that item and shall be used in determining the total amount of the proposal.

Hazardous Waste - Wastes that are regulated or "listed" under RCRA (40 CFR 261), or are ignitable, corrosive, reactive, or toxic.

Hertz - A measure of the length of a cycle of alternating current expressed as the number per second.

Highway, Street, or Road - A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

Holidays, Legal - In the State of Mississippi, holidays occur on:

January 1 - New Year's Day

Third Monday in January - Robert E. Lee and Dr. Martin Luther King, Jr.'s Birthday

Third Monday in February - Washington's Birthday

Last Monday in April - Confederate Memorial Day

Last Monday in May - National Memorial Day and Jefferson Davis' Birthday

July 4 - Independence Day

First Monday in September - Labor Day

November 11 - Armistice (Veterans') Day

Thanksgiving Day - As Proclaimed

December 25 - Christmas Day

When a legal holiday falls on a Saturday or Sunday, the succeeding Monday will be observed as a legal holiday.

In-Grade - The top course or portion of the work which is in place at the time a subsequent material or course is to be placed thereon.

In-Grade Preparation - In-grade preparation is the preparation of material in place to receive other materials or processing required in super-imposed construction.

Inspector - The Engineer's authorized representative assigned to make detailed inspections of contract performance.

Interim Specifications - Interim Specifications are contract provisions other than Standard and Supplemental Specifications approved for general use in all applicable contracts until changes in technology or other conditions indicate revisions should be made for subsequent contracts.

Intermediate Course - A combination of graded aggregate and bituminous material which constitutes the lower layer or layers of a flexible pavement, but not part of the base course.

Invitation for Bids - The advertisement for proposals for all work or materials on which bids are required. The advertisement will indicate with reasonable accuracy the quantity and location of the work to be done or the character and quantity of the material to be furnished and the time and place of the opening of proposals.

Laboratory - The testing laboratory of the Department or any other testing laboratory which may be designated by the Engineer.

Legend - The words, letters and arrows, and other symbols or markings shown on the plans and designated as legend, required to be placed on the surface of a pavement in the form of paint and glass beads, thermoplastic and glass beads or other similar specified materials, to serve as pavement markings.

Local Traffic - Traffic whose origin or destination is adjacent to that part of the highway under construction.

Major and Minor Contract Items - A major item of work shall be defined as an item whose total monetary value, determined by multiplying the proposal quantity by the contract unit price, is equal to or greater than ten percent of the original total contract amount. Unless otherwise specifically shown in the contract, all other items shall be considered minor items. Minor items shall become major items when increased to the extent that the total monetary value of such item at the original contract unit price is equal to or greater than ten percent of the original total contract amount.

Materials - Any substances specified for use in the construction of the project and its appurtenances.

Notices to Contractors - Pre-bidding notices to prospective bidders, including the advertisement and other pertinent pre-bid information labeled as Notice to Contractors.

Notice to Bidders - All notices, issued to the prospective bidders, pertaining to or establishing requirements governing the submission of proposals, quantities or qualities of materials or work, the performance of the work, or payment therefor.

Notice to Proceed - Written notice to the Contractor to proceed with the contract work including, when applicable, the date of beginning of contract time.

Omitted Section - A section within the designated project limits in which no work, excluding construction signing, approaches and/or temporary connections, is to be performed, and the Contractor does not have any responsibility for maintenance of the roadway or traffic unless specifically provided for in the contract.

Optional Items - Items listed in the bid schedule of the proposal which are considered to be comparable for the purpose intended, and the Contractor is required to make a selection prior to or at the time of execution of the contract.

Pavement - The portion of the roadbed constructed upon the base course and specifically constructed as the contact element for vehicular traffic.

Pavement Structure - The combination of a pavement and a base course placed on a subgrade to support the traffic load and distribute it to the roadbed.

Plans - The approved plans, profiles, typical cross-sections, working drawings and supplemental drawings, or exact reproduction thereof, which show the location, character, dimensions, and details of the work to be done. When the contract does not have an official set of plans, reference to the plans shall mean the contract documents.

Profile Grade - The trace on a vertical plane intersecting the top surface of the proposed wearing surface as shown on the plans or established by the Engineer, usually along the longitudinal centerline of the roadbed. Profile grade means either elevation or gradient of such trace according to the context.

Progress Schedule - A bar graph showing the work phases under the contract and each bar represents a controlling phase of the work. The bars show the planned sequence of operations and the time at which each of the phases is to begin and end. The schedule will be developed by the Department or by the Contractor with Department approval.

Project - A specific section of highway or other prescribed limits of work as described by the plans and contract documents including approaches and/or temporary connections together with all appurtenances and construction to be performed thereon under the contract.

Proposal - The offer of a bidder, on the prescribed form, to perform the work at the prices quoted.

Proposal Form - The approved form on which the Department requires bids to be prepared and submitted for the work.

Proposal Guaranty - A certified check, cashier's check or bid bond furnished with the bid to guarantee that the bidder will enter into a contract for the work and furnish acceptable bond if the Contractor's bid is accepted.

Quantity Adjustment - A modification of contract quantities covering increases or decreases resulting from plan errors, omissions or changes necessary to carry out the intent of the plans.

Questionnaire - The specified forms on which the Contractor shall furnish, when requested, information as to the Contractor's ability to perform and finance the work.

Resident or Project Engineer - The Engineer assigned by the Chief Engineer and bonded to the State to have immediate charge of the engineering details and the responsibility and authority for on-the-job administration necessary for the satisfactory completion of the work in accordance with the contract.

Retainage - A general term denoting funds withheld from partial payments.

Right-of-Way - A general term denoting land, property, or interest therein, usually in a strip, acquired for or devoted to a highway and its appurtenances.

Roadbed - The graded portion of a highway within top and side slopes prepared as a foundation for a pavement structure and shoulders.

Roadside - A general term denoting the area adjoining the outer edge of a roadway. Extensive areas between the roadways of a divided highway are also considered to be roadside.

Roadside Development - Those items necessary to the complete highway which provide for a preservation of landscape materials and features; the rehabilitation and protection against erosion of all areas disturbed by construction through seeding, sodding, mulching and the placing of other ground covers; and such suitable planting, other improvements and public facilities as may increase the effectiveness and usefulness and enhance the appearance of the highway.

Roadway - All surface portions of the highway between shoulder lines. Divided highways are considered to have two roadways.

Roadway Structure - All vertical and horizontal elements of the work, exclusive of bridges, designed to provide and support the roadway.

Shoulders - The portion of the roadway contiguous with the traveled way for the lateral support of the other elements of the pavement structures, and for emergency use of stopped vehicles.

Sidewalk - That portion of the road, highway, or street primarily constructed for use by pedestrians.

Special Provisions - Additions and revisions to the Standard and Supplemental Specifications covering conditions peculiar to an individual project, and included in the proposal assemblies.

Specifications - A general term applied to all directions, provisions and requirements pertaining to performance of the work.

Specified Completion Date - The date on which the contract work is specified to be completed.

State - The State of Mississippi acting through its authorized representative.

Structures - Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, endwalls, buildings, sewers, service pipes, underdrains, foundation drains, and similar features which may be required in the work.

Subcontractor - An individual, partnership, firm, or corporation to whom the Contractor, with the written consent of the Executive Director, sublets part of the contract.

Subgrade - The top surface of a design soil upon which the pavement structure and shoulders are constructed.

Substructure - Those parts of a bridge below the bearings of simple and continuous spans, below the bottom surfaces of concrete box girder spans in which the piers form an integral part of the span-pier unity, below skew-backs of arches, below tops of footings of rigid frames, and below wingwalls of abutments.

Superintendent - The Contractor's authorized representative in responsible charge of the work.

Superstructure - All parts of a bridge above and exclusive of the substructure.

Supplemental Agreement - A written agreement on a form provided by the Department, between the Contractor and the Commission with the assent of the Contractor's Surety and the approval of all agencies involved, covering alterations or unforeseen work necessary for the completion of the work within the intent of the contract.

Supplemental Specifications - Additions to the Standard Specifications that are adopted subsequent to issuance of this book, and which are printed in volume form and issued under the title of "Supplemental Specifications," and considered

as part of the Standard Specifications.

Surety - A corporate body, qualified under the laws of Mississippi, which is bound with and for the successful bidder by a "contract bond" to guarantee acceptable performance of the contract and payment of all legal taxes and debts pertaining to the construction of the project, including payment of State Sales Tax as prescribed by law, and any overpayment made to the Contractor.

Temporary Structures - Structures required to maintain traffic while the Contractor constructs permanent structures. The temporary structure shall include the earth approaches thereto unless otherwise specified.

Time Unit - A division of the total contract time allowed, pro-rated monthly on the basis of the normal earning power for an eight-hour unit of work.

Titles (or Headings) - The titles or headings of the sections and subsections herein are intended for convenience of reference and shall not be considered as having any bearing on their interpretation.

Township, Town, City or District - A subdivision of the county used to designate or identify the location of the proposed work.

The Work - The furnishing of all labor, materials, equipment and incidentals necessary or convenient to the successful completion of the project and the carrying out of the duties and obligations imposed by the contract.

Travelled Way - A portion of the roadway improved, designed or ordinarily used for vehicular travel, exclusive of shoulders or berms.

Underground Storage Tanks - Any one or combination of tanks, including underground pipes connected thereto, which are used to contain an accumulation of regulated substances and the volume of which, including underground pipe volume, is ten percent or more beneath the surface of the ground.

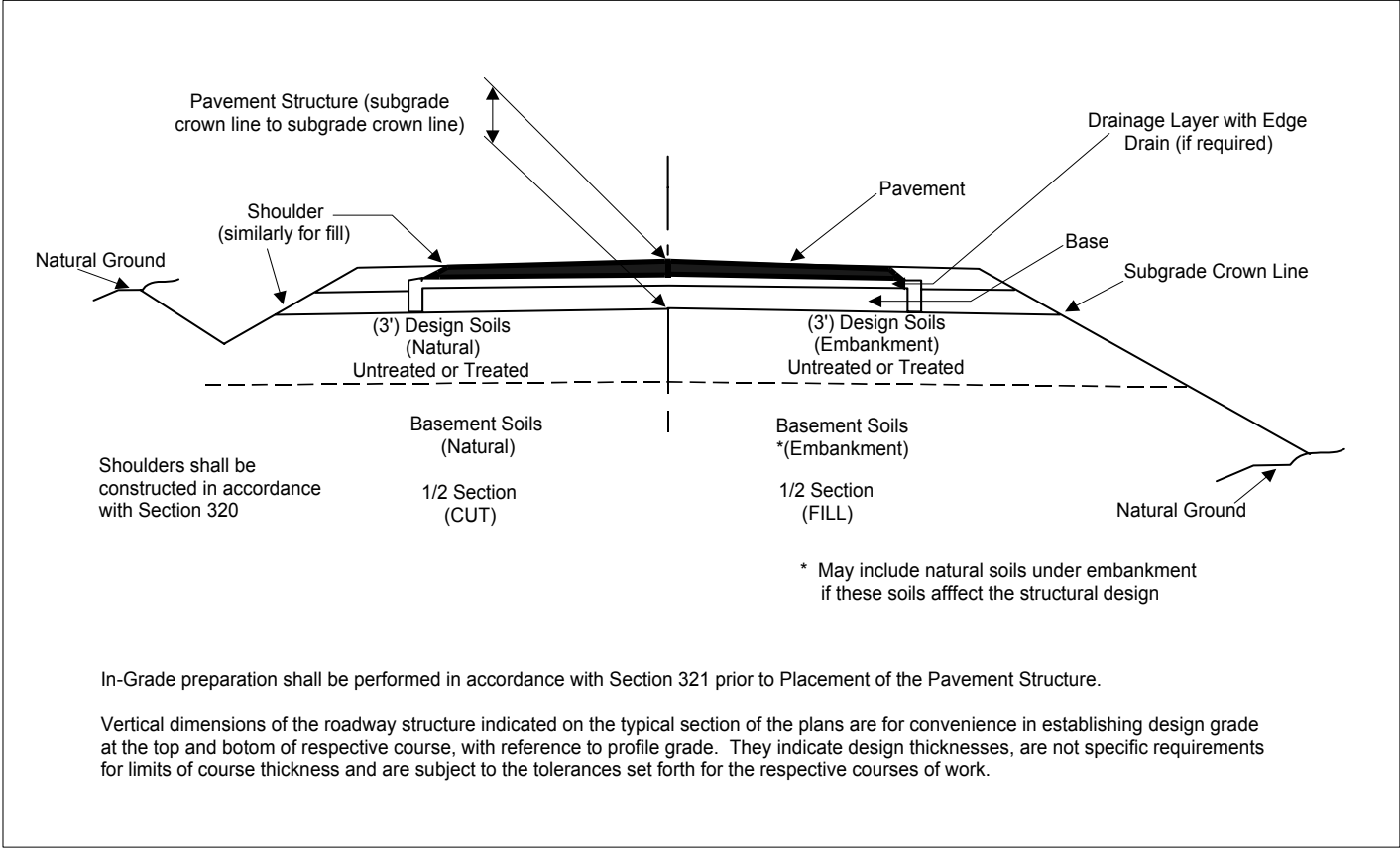
Wetlands - As defined in EPA and Corps of Engineer's (Corps) regulations and clarified in the Corps 1987 Wetlands Delineation Manual, or sequent Federal wetland delineation manuals.

Working Drawings - Stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data which the Contractor is required to submit to the Engineer for approval.

Work Order - A written order, signed by the Engineer, of contractual status requiring performance by the Contractor without negotiation of any sort.

Work Phase - A contract item or group of associated items that should be in progress at the time as a controlling phase for the orderly completion of the work within contract time. See Progress Schedule.

101.03--Presumption. To avoid repetition of expressions, it is provided that any directive, action or opinion that is not so denoted shall be understood to be followed by the words "by the Engineer" or "to the Engineer."



SECTION 102 - BIDDING REQUIREMENTS AND CONDITIONS

102.001--Advertisement. In conformity with State law, the Commission will publish a Notice to Contractors giving notice of a request for bids, this notice will become one of the contract documents if award is made.

The advertisement will state the time and place for submission of sealed proposals; the location and description of the proposed work; estimates of the quantities and kinds of work to be performed or materials to be furnished and a schedule of pay items for which unit bid prices are asked; specified contract time; and instructions to bidders regarding proposal forms, basis of award, proposal guaranty required, plans, specifications, labor requirements, special provisions and other pertinent information.

102.01--Prequalification of Bidders. Prospective bidders will be required to file with the Department a list of persons authorized to bind the company in all matters. Other information may be required from time to time before issuing proposals.

The attention of prospective bidders is directed to all fees and taxes required for the privilege of doing business within the State of Mississippi.

As a condition precedent to the opening of a bid, the total amount of which is equal to or in excess of \$50,000.00 and financed 100% with State funds, the bidder must have a certificate of responsibility issued by the Mississippi State Board of Public Contractors or a similar certificate issued by another state recognizing such certificate issued by the State of Mississippi. The Bidder's Certificate of Responsibility number or a statement signifying that the bid is not in excess of \$50,000.00 must be shown on the outside of the sealed envelope containing the bid proposal.

When two or more persons, firms or corporations are submitting a joint venture, each of the persons, firms or corporations may be required to comply with the above prequalification requirements.

102.02--Contents of Proposal Forms. The proposal forms, designated as Section 905 of the contract documents, will state the location and description of the contemplated construction, will show estimates of the kinds and quantities of work to be performed or materials to be furnished, and will have a schedule of items for which unit bid prices are invited. It will state the time in which the work must be completed. The proposal will also include special provisions and requirements which are not contained in the Standard Specifications or required modifications thereto.

All papers bound with, attached to, or designated for addition or substitution in the proposal are considered a part thereof and must not be detached or altered

when the proposal is submitted.

The plans, specifications and other documents designated in the proposal shall be considered a part as if attached to and included in the proposal.

The prospective bidder will be required to pay the Department the sum stated in the Notice to Contractors for each copy of the proposal form.

102.03--Issuance of Proposal. Except as hereinafter set forth, the Department will, upon request, furnish the prospective bidder with a proposal. The Department reserves the right to refuse to issue a proposal to a prospective bidder for the following reasons:

- (a) Lack of competency and adequate machinery, plant, or other equipment, as revealed by the information obtained as provided in Subsection 102.01 or other determinations made by the Department.
- (b) Uncompleted work which, in the judgment of the Department, might hinder or prevent the prompt completion of additional work if awarded.
- (c) Failure to pay, or satisfactorily settle, all bills due for labor and material on former contracts in force at the time of issuance of proposals.
- (d) Unsatisfactory performance on previous contracts.
- (e) Failure to promptly reimburse the Department for any overpayment that might have occurred.
- (f) Debarment of a prospective bidder or any of its corporate officers or principal owners by the Mississippi Transportation Commission.

102.04--Interpretation of Quantities in Bid Schedule. The quantities appearing in the bid schedule are approximate only and have been prepared for the comparison of bids. Payment to the Contractor will be made only for the actual quantities of work performed and accepted or materials furnished and accepted in accordance with the contract. The scheduled quantities of work to be done and materials to be furnished may each be increased, decreased, or omitted as hereinafter provided.

102.05--Examination of Plans, Specifications, Special Provisions, Notices to Bidders and Site of Work. It is the intent that the Department will prepare full, complete, and accurate plans and specifications giving directions that will enable any competent contractor to carry them out. The bidder is required to examine carefully the site of the proposed work, the proposal, plans, specifications, special provisions, notices to bidders and contract forms before submitting a proposal. The submission of a bid shall be considered prima facie evidence that

the bidder has made such an examination and is satisfied as to the conditions to be encountered in performing the work and as to the requirements of the plans, standard specifications, supplemental specifications, notices to bidders, special provisions, contract, and the Federal, State, and local laws which will in any way affect the execution of the work. All contracts are subject to the provisions of Sections 65-1-89 and 65-1-91, Mississippi Code of 1972, Annotated.

Bidders may inspect records of the Department as to investigations made, subject to the conditions set forth herein.

Boring logs and other records of subsurface investigations are available for inspection by bidders. It is understood that such information was obtained and is intended for Department design and estimating purposes only. It is made available to bidders so they may have access to identical subsurface information available to the Department and is not intended as a substitute for personal investigation, interpretations and judgment of the bidders.

In order to make the most effective use of available engineering personnel, the Department is unable to assign engineering responsibilities at the time of contract preparation; however, the District Construction Engineer will, by appointment, personally be available or will arrange for representative to be available to lend assistance to prospective bidders for plan-in-hand review of the proposed work features, and, if desirable, field inspection of the site of the proposed work. The Resident or Project Engineer for the contract will be assigned as soon as the Department can reasonably make an appropriate determination.

102.06--Preparation of Proposal. The bidder's proposal shall be submitted upon the forms furnished by the Department and shall enter in figures a unit price and extension in the appropriate columns for each bid item exclusive of those items for which a fixed contract unit price and the extension are shown. Lump sum bid items are to be bid as an item total only since a unit price is not required. The bidder shall also enter where indicated the subtotal amount for each of the various divisions and the total amount of the proposal which shall also include the extensions of the items with a fixed contract unit price. In case of discrepancy between a unit price and the extension, the unit price will govern and the extension along with the total amount of the proposal will be corrected. All the figures shall be in ink or typed.

When the bid schedule contains a fixed contract unit price (FCP) for an item, this price shall be the contract unit price for the item and no alteration shall be made by the bidder.

When an item in the proposal contains a choice to be made by the bidder, the bidder shall indicate the choice in accordance with the INSTRUCTION TO BIDDERS in Section 905 - Proposal; reference is made to Alternate Designs, Alternate Items, and Optional Items as defined in Subsection 101.02.

Where the bid schedule lists alternate designs or alternate items, the one alternate bid shall be designated by drawing a line or lines through other listed alternate(s) as provided, and thereafter no further choice will be permitted.

Bid sheets generated by the Department's Electronic Bid System (EBS) along with a completed proposal package will constitute the official bid and shall be signed on the last sheet of the EBS generated bid sheets and delivered to the Department in accordance with the provisions of Subsection 102.09.

Bidders are cautioned that using older versions of the EBS will result in improperly printed bid sheets. The latest version of the EBS can be obtained at no cost from the MDOT Contract Administration Division or at the MDOT website, www.gomdot.com.

If bidders submit EBS generated bid sheets, then the bid sheets included in the proposal should not be completed. The EBS generated bid sheets should be stapled together and included in the bid proposal package in the sealed envelope. If both the forms in the proposal and the EBS generated bid sheets are completed and submitted, only the EBS generated sheets will be recognized and used for the official bid. The diskette containing the information printed on the EBS generated bid sheets should be placed in the pouch located on the inside of the front cover of the bid proposal package. Bid sheets printed from the EBS should be a representation of the data returned on the diskettes. To have a true representation of the bid sheets, the Bidder must copy the inputted unit prices back to the diskette by using the option titled "Copy Project File To Floppy Disk" from the drop-down menu under "Projects". Otherwise, the unit prices bid will not be recorded to the diskette. Bidders are cautioned that failure to follow proper diskette-handling procedures could result in the Department being unable to process the diskette. Any modification or manipulation of the data contained on the diskette, other than entering unit bid prices, will not be allowed and will cause the Contractor's bid to be considered irregular.

It is the responsibility of every bidder to check for any addendum or modification to the contract document(s) for which they intend to submit a response. It shall be the bidder's responsibility to be sure they are in receipt of all addenda, pre-bid conference information, and/or questions and answers provided at, or subsequent to, the pre-bid conference, if any are issued.

The Mississippi Transportation Commission has no responsibility for defects, irregularities or other problems caused by the use of electronic media. Operation of this electronic media is done at the sole risk of the user.

When the bid schedule lists optional items, the Contractor's selection may, but is not required to, be made at the time of bidding. For optional items not pre-selected, the Contractor's selection shall be made prior to or at the time of execution of the contract.

Each proposal issued will contain duplicate Certification regarding debarment, suspension, and other responsibility matters to be completed by the bidder. The Certification must be sworn to and shall be under penalty of perjury and bidders are cautioned to read and understand its contents in entirety before execution.

The Contractor shall provide immediate written notice to the Contract Administration Engineer Division at any time, prior to or after award, that it is known a certification was erroneous when executed or has become erroneous by reason of changed circumstances.

Failure on the part of the bidder to execute the Certification will result in the proposal being rejected.

The bidder's proposal must be signed with ink by the individual, by one or more members of the partnership, by one or more members or officers of each firm representing a joint venture, or by one or more officers of a corporation; or by an agent of the Contractor legally qualified to bind the Contractor and acceptable to the State. If the proposal is made by an individual, the individual's name and address must be shown; by a partnership, the name and address of each partnership member must be shown; as a joint venture, the name and address of each member or officer of the firms represented by the joint venture must be shown; by a corporation, the name of the corporation and the business address of its corporate officials must be shown.

The address stated on the proposal shall be the bidder's permanent address until changed by written notice to the Executive Director. All notices provided for in the contract shall be considered as delivered to the Contractor when mailed or delivered to such address.

102.07--Irregular Proposals. Proposals will be considered irregular and may be rejected for any of the following reasons:

- (a) If the proposal is on a form other than that furnished by the Department, or if the form is altered or any part thereof is detached, except as allowed in Subsection 102.06.
- (b) If there are unauthorized additions, conditional or alternate bids, or irregularities of any kind which may tend to make the proposal incomplete, indefinite, or ambiguous as to its meaning.
- (c) If the bidder adds any provisions reserving the right to accept or reject an award, or to enter into a contract pursuant to an award.
- (d) If the proposal does not contain a unit price and extension for each pay item, except in the case of alternate pay items and when the unit of measurement is lump sum.

- (e) If the proposal, Section 905, does not contain acknowledgement of receipt and addition to the proposal and contract documents of all addenda issued prior to opening of bids.
- (f) Failure to execute required affidavits, certificates, etc., and furnish proposal guaranty.
- (g) The Mississippi Transportation Commission reserves the right to reject any or all proposals, to waive technicalities or irregularities, or to advertise for new proposals, and the decision of the Commission to reject any bid or proposal shall not be cause for any liability or damage against the Commission, the Department, any of its officers or employees.

102.08--Proposal Guaranty. No proposal will be considered unless accompanied by certified check, cashier's check or bid bond, made payable to the State of Mississippi, in an amount of not less than five percent of the total amount of the proposal offered. The guaranty shall be evidence of good faith that, if awarded the contract, the bidder will execute the contract and give contract bond as stipulated in Subsection 103.05 and as required by law.

If a bid bond is offered as guaranty, the bond must be on a form approved by the Executive Director, made by a Surety acceptable to the Executive Director and signed or countersigned by a qualified Mississippi resident agent and the bidder.

102.09--Delivery of Proposals. Unless otherwise specified, each proposal shall be submitted sealed in a special envelope furnished by the Department. The blank spaces on the envelope shall be filled in correctly to clearly indicate its contents. When an envelope other than the special one furnished by the Department is used, it shall be of the same general size and shape and be similarly marked to clearly indicate its contents. Proposal Forms are non-transferable and no name or names of interested parties may be shown other than those to whom the proposal was issued. When sent by mail, the sealed proposals shall be mailed to the Department at the address and in care of the official in whose office the bids are to be received. All proposals shall be filed prior to the time and place specified in the Notice to Contractors. Proposals received after the time for opening of bids will be returned to the bidder unopened.

102.10--Withdrawal or Revision of Proposals. A bidder may withdraw or revise a proposal after it has been deposited with the Department, provided the Executive Director has received, in writing or by telegram, the request for such withdrawal or revision prior to the time set for opening proposals.

102.11--Combination Bids. Combination bids which combine two or more individual projects may be submitted by stating in writing on each project proposal to be considered in the combination, one of the following:

- (a) That the bidder is bidding on "All or None" of the work for designated proposals. The Department will evaluate all bids on these proposals and make awards based on the bids most advantageous to the State.
- (b) The reduction the bidder will make in the unit price of one or more of the items in any or all of the proposals if awarded the combination; however, the bidder will not be permitted to make a reduction in any unit price that may be fixed by the Department in the proposal. The Department will select from the proposals submitted the individual or combination bids most advantageous to the State.
- (c) That the bidder is bidding on a number of projects but desires to be awarded work not to exceed a specified total amount or a specified number of contracts. The Department will select from the bidder's proposal those which are most advantageous to the State within its specified amount or total number of contracts.

Combination bids which state that a lump sum shall be deducted from the final estimate or retained percentage, or that a reduction in prices shall be made on a percentage basis, or that states that award of a job is contingent upon being awarded another job will not be accepted and the bids with which such a letter is submitted will be considered irregular and rejected.

102.12--Public Opening of Proposals. Proposals will be opened and read publicly at the time and place indicated in the proposal. Bidders, their authorized agents, and other interested parties are invited to be present.

102.13--Disqualification of Bidders. Either of the following reasons may be considered as being sufficient for the disqualification of a bidder and the rejection of the bidder's proposal or proposals:

- (a) More than one proposal for the same work from an individual, partnership, firm or corporation under the same or different name(s). However, the Commission may accept proposals on construction contracts from commonly owned but independently managed companies, so long as each bid is not the result of collusion and is accompanied by the required certificate regarding collusion.
- (b) Evidence of collusion among bidders. Participants in such collusion will receive no recognition as bidders for any future work of the Department until reinstated as a qualified bidder.

102.14--Material Guaranty. At the option of the Department, the successful bidder shall be required at any time before or after the award or execution of the contract to furnish a complete statement of the origin, composition and manufacture of any or all materials to be used in the construction of the work and

shall provide the Department with access to all sources of materials for sampling and testing to determine their quality, uniformity and fitness for the work in accordance with the contract.

SECTION 103 - AWARD AND EXECUTION OF CONTRACT

103.01--Consideration of Proposals. After the proposals 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 and the unit prices bid. The results of comparisons will be immediately available to the public. In the event of a discrepancy between any unit price and its extension, the unit price shall govern.

Resident Contractors actually domiciled in Mississippi which may be corporate, individuals or partnerships are to be granted preference over nonresidents in awarding of contracts financed 100% with State funds as provided herein.

In consideration of contract proposals which are equal to or in excess of \$50,000 and financed 100% with State funds, a nonresident bidder domiciled in a state having laws granting preference to local Contractors will be considered for such contracts on the same basis as the nonresident bidder's state awards contracts to Mississippi Contractors bidding under similar circumstances. When a nonresident Contractor submits a bid equal to or in excess of \$50,000 on a contract financed 100% with State funds, a copy of the current laws from the state of domicile and an explanation thereof pertaining to treatment of nonresident Contractors shall be attached. If no preferential treatment is provided for Contractors in the state of domicile and contracts are awarded to the lowest responsible bidder, a statement to this effect shall be attached. Should the attachment not accompany the bid when submitted, the Contractor shall have 10 days following the opening of the bids to furnish the required information to the Contract Administration Engineer for attachment to the bid. As used herein, the term "resident Contractors" includes a nonresident person, firm or corporation that has been qualified to do business in this State and has maintained a permanent full-time office in the State of Mississippi for two years prior to January 1, 1986, and the subsidiaries and affiliates of such a person, firm or corporation.

103.02--Award of Contract. The award of a contract, if awarded, will be made within 60 calendar days after the opening of proposals to the lowest responsible, except as provided in Subsection 103.01 for preferential treatment situations, and qualified bidder whose proposal complies with all the requirements prescribed. The award of contracts involving the expenditure of Federal funds is contingent upon concurrence of the Federal Agency whose funds are being used. The successful bidder will be notified of the award by letter mailed to the address shown on the proposal.

103.03--Cancellation of Award. The Department reserves the right to cancel the award of a contract any time prior to the execution by all parties without liability against the Commission, Department, or any of its officers or employees.

103.04--Return of Proposal Guaranty. Bid bonds will not be returned.

Certified checks or cashier's checks submitted as proposal guaranties, except those of the two lowest bidders, will be returned following the opening and checking of the proposals. The retained proposal guaranty of the unsuccessful of the two lowest bidders will be returned within ten days following the award of contract and that of the successful bidder will be returned after a satisfactory contract bond has been furnished and the contract has been executed.

In the event no award is made within 30 days after the opening of bids, the Executive Director may permit the successful bidder to replace the certified check or cashier's check with a satisfactory bidder's bond.

Should no award be made within 60 calendar days, all proposals will be rejected and all guaranties returned unless the lowest responsible bidder, at the request of the Commission, agrees in writing to a longer delay.

103.05--Requirement of Contract Bond. Prior to the execution of the contract, the successful bidder shall execute and deliver to the Executive Director a contract bond or bonds in a sum equal to the full amount of the contract. In the event of award of a joint bid, each individual, partnership, firm or corporation shall assume jointly the full obligations under the contract and contract bond. The form of the bond(s) shall be that provided by or acceptable to the Department. The bond(s) shall be negotiated for, procured from and the premium paid to a qualified Mississippi resident agent of the Surety. The bond shall be signed or countersigned by a Mississippi resident agent and also bear the signature of an "attorney-in-fact" of the surety. Reference is made to Section 31-5-51 et seq of the Mississippi Code of 1972, Annotated, and other State statutes applicable thereto.

103.06--Blank.

103.07--Execution and Approval of Contract. The successful bidder to whom the contract has been awarded shall sign and file with the Executive Director the contract and all documents required by the contract within 10 days after the contract has been mailed to the bidder. The contract may require certain documents be submitted at an earlier date, in which case, those documents shall be submitted within the time frame specified. If the contract is not executed by the Department within 15 days following receipt of the signed contract and all necessary documents, the bidder shall have the right to withdraw the bid without penalty. No contract is in effect until it is executed by all parties.

103.08--Failure to Execute Contract. Failure of the bidder to execute the contract and file acceptable bond and/or other required documents within 10 days shall be just cause for the cancellation of the award and forfeiture of the proposal guaranty which shall become the property of the Department, not as a penalty but in liquidation of damages sustained. Award may then be made to the next lowest responsible bidder, or the work may be readvertised at the discretion of the Department.

SECTION 104 - SCOPE OF WORK

104.01--Intent of Contract. The intent of the contract is to provide for the execution, construction, and completion in every detail of the work described, and to compensate the Contractor for all acceptable work performed in accordance with the provisions of the contract. The Contractor shall furnish all labor, materials, equipment, supplies, transportation, supervision, methods and procedures necessary to complete the work in accordance with the plans, specifications and terms of the contract.

104.02--Alterations of Plans or Character of Work. Except as may be necessary to satisfactorily complete the contract, no alterations of the plans or the nature of the work will involve work beyond the termini of the contemplated construction without modification of the contract and approval by all parties concerned.

The Department reserves the right to make, in writing, at any time during the work, such changes in quantities and such alterations in the work as are necessary to satisfactorily complete the project. Such changes in quantities and alterations shall neither invalidate the contract nor release the Surety, and the Contractor agrees to perform the work as altered.

Wherever in the Specifications a supplemental agreement is provided for, such supplemental agreement must be approved by the Commission and spread upon its minutes prior to execution by the Executive Director.

104.02.1--Significant Changes in the Character of Work. Before any consideration will be given for an adjustment to the contract, it must be determined that a significant change in the character of the work has occurred. A Significant change in quantity of a major item, plus or minus twenty-five percent (25%) variation from original quantity, in and of itself, does not constitute a significant change in the character of work. The character of the work, as altered, has to differ materially in kind or nature from that involved or included in the original proposed construction.

If the alterations or changes in quantities significantly change the character of the work under the contract, whether such alterations or changes are in themselves significant changes to the character of the work or by affecting other work cause

such other work to become significantly different in character, an adjustment, excluding anticipated profit, will be made to the contract. The basis for the adjustment shall be agreed upon prior to the performance of the work. If a basis cannot be agreed upon, then an adjustment will be made either for or against the Contractor in such amount as the Engineer may determine to be fair and equitable.

If the alterations or changes in quantities do not significantly change the character of the work to be performed under the contract, the altered work will be paid for as provided elsewhere in the contract.

The term "significant change" shall be construed to apply only to the following circumstances:

When the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction or

When a major item of work, as defined in Subsection 101.02, is increased in excess of 125 percent or decreased below 75 percent of the original contract quantity. Any allowance for an increase in quantity shall apply only to that portion in excess of 125 percent of original contract item quantity, or in case of a decrease below 75 percent, to the actual amount of work performed.

Items, quantities, unit prices and amounts, or revisions thereof, established in the contract by supplemental agreement shall be considered as original contract items, quantities, prices, amounts and totals thereof.

When a major item is eliminated, the Contractor will be reimbursed for substantiated unrecovered overhead costs but not to exceed five percent of the original contract value of the item. The Contractor shall not be entitled to nor shall the Commission, the Department, or any of its officers or employees be subjected to any liability or damages.

The Contractor upon request will be paid substantiated actual costs for materials, which are in excess of those used and paid for in the completed work that were mobilized prior to notification of elimination or reduction of a major item. Materials which otherwise would have been required prior to such notification and which are on order that cannot be cancelled may be included in the materials to be paid for by the Department. No payment will be allowed for materials in excess of the quantity required under the contract.

Points of delivery for the reimbursed materials shall be agreeable to the Department. The Contractor shall make delivery at such point and the additional transportation cost, if any, will be reimbursed by the Department.

Mobilization of materials as indicated in this provision shall be understood to be

materials which qualify for partial payment under the provisions of Subsection 109.06, and cannot be reasonably used by the Contractor in other work under contract.

At the option of the Department, living or perishable plant materials, seeds, other materials and warehouse items mobilized for the work may be purchased by the Department.

All mobilized materials for which payment is made shall become the property of the Department, and the Contractor shall furnish the Engineer satisfactory title or other approved evidence of ownership.

104.02.2--Differing Site Conditions. During the progress of the work, if subsurface or latent physical conditions are encountered at the site differing materially from those indicated in the contract or if unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the contract, are encountered at the site, the Contractor shall promptly notify the Engineer in writing of the specific differing conditions before the affected work is performed.

Upon written notification by the Contractor, the Engineer will investigate the conditions, and if it is determined that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the contract, an adjustment, excluding anticipated profits, will be made and the contract modified in writing accordingly. The Engineer will notify the Contractor of the determination whether or not an adjustment of the contract is warranted.

No contract adjustment which results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice. The written notice shall be submitted upon the forms provided and required by the Department.

Before beginning or continuing work which justifies an adjustment of the contract unit price or time under the above provisions, a supplemental agreement acceptable to all parties shall be executed. In the event an agreement acceptable to all parties cannot be reached, the Department may order the work to proceed and that part of the work will be paid for in accordance with Subsection 109.04.

If the altered or added work is of a character as to require more than the normal time to complete the work, an adjustment of the contract time may be made.

104.02.3--Minor Alterations to the Contract. When the Department makes alterations in the details of construction or specifications that are minor in nature, the Resident or Project Engineer may elect to make an adjustment to the contract under the provisions of this subsection. Minor alterations shall be defined as

those alterations to the contract that are not addressed in the Standard Specifications, or supplements thereto, and are valued at less than \$10,000.00. The District Engineer shall designate, in writing, the Resident or Project Engineer authorized to execute the Class I Supplemental Agreement. The Resident or Project Engineer and Contractor shall agree upon the scope of work and a lump sum amount, within the above stated limit, for the work to be performed. The agreement shall be reflected in a Class I Supplemental Agreement signed by the Resident or Project Engineer and the Contractor's authorized representative, which, when it bears both the signature of the Resident or Project Engineer and Contractor, shall constitute the scope of work and the sole and only basis for payment by the Department or Commission under the item "Minor Alterations to the Contract." Work shall not proceed until both parties sign the agreement.

Any adjustment of contract time due to Minor Alterations will be in accordance with Subsection 108.06 of the Standard Specifications.

Payment will be made under:

104-A S/A: Minor Alterations to the Contract

- lump sum

This pay item will not to be included on the plans or in the original contract proposal.

104.03--Extra Work. The Contractor shall perform unforeseen work, for which there is no price included in the contract, whenever it is deemed necessary or desirable by the Engineer in order to complete fully the work as contemplated. Such work shall be performed in accordance with the applicable specifications and as directed. Payment or adjustment in payment will be made as provided under Subsection 109.04.

104.04--Maintenance of Traffic. Unless otherwise provided, the road under construction and all other roads and entrances to adjacent property within the right-of-way will be kept open to through and local traffic.

The Contractor shall keep the portion of the project being used by public traffic in satisfactory condition for traffic to be adequately accommodated. The Contractor shall also provide and maintain in a safe condition temporary approaches or crossings and intersections with trails, roads, streets, businesses, parking lots, residences, garages, and farms. Employees of the Department and the Federal agency involved shall have access to all portions of the project at all times.

On any facility which traffic is maintained, mowing shall be performed as necessary as determined by the Engineer to provide reasonable appearance and safety to the traveling public. Mowing shall be performed at the direction and

satisfaction of the Engineer, and shall include those areas from the edge of the pavement to a minimum of five feet beyond the shoulder line. The cost of mowing shall be absorbed in other contract items when the contract does not contain a bid item for mowing, and shall not be the basis for any additional payment.

In case it is necessary or desirable to close a portion of the project to traffic, the plans, special provisions, or other contract documents will so indicate, or in case provisions are not made on the plans or in other contract documents, the Engineer may permit in writing temporary closures of small portions of the project as deemed necessary to expedite the work without compromising the convenience and safety of traffic.

The Contractor shall be bound by the provisions of this subsection and other applicable provisions of the contract with regard to the safe and convenient passage of traffic.

In the case of a project for improvements or construction alongside an existing roadway on which traffic is required to be maintained, no equipment, vehicles or materials will be permitted to park or be stored within the clear/safety zone of the roadway unless it is behind a lane or shoulder closure. Unless working under an approved night time operation, the Contractor shall not perform any work within the clear/safety zone of the roadway between sunset and sunrise.

The Contractor shall not obstruct any traffic facility or connection thereto which is officially opened to public or private traffic or required under the contract to be maintained except as permitted in writing by the Engineer on the basis that other suitable provisions have been made.

Due to accident possibilities for certain days of peak traffic use, the right is hereby reserved for the District Engineer to suspend upon due notice to the Contractor any operation which, if allowed to be carried on, would seriously jeopardize the safety of the traveling public on holidays, the preceding day, and the following day or on days of major public events in the general area. The notice will specifically state the dates of the suspension. When work is suspended as provided herein, the affected phase(s) will be considered as zero for assessment of contract time. Additional compensation will not be paid because of such suspension.

The Contractor will not be directly compensated for constructing, maintaining and removing temporary traffic maintenance facilities unless:

- (a) the proposal contains pay items specifically covering such work, or
- (b) the plans or other contract documents specifically indicate that quantities involved are to be measured for payment.

The Contractor will be paid for work required to restore and/or maintain traffic which is caused by snow, ice, major flooding, landslide or phenomenon of nature such as an earthquake, hurricane, tornado, etc. when damage from such cause is beyond the control of and without the fault or negligence of the Contractor.

If the Engineer orders special maintenance of traffic over and above the requirements specified in the contract for the benefit of the traveling public, the ordered work shall be accomplished as provided in Subsection 104.03 -- Extra Work.

Unsatisfactory maintenance of traffic shall be subject to the procedures provided in Subsection 105.15.

104.05--Removal and Disposal of All Materials From the Project. The Contractor shall remove and dispose of all existing structures and obstructions in accordance with the provisions of Section 202. In the event separate pay items are not provided, the cost of removal and disposal shall be included in prices bid for items under Sections 201 and 203.

The Contractor shall not remove or disturb any buildings, public utilities or other improvements that are to be removed and/or replaced by the Department or owners under separate agreement.

It is anticipated that obstructions to be removed by the Department or owners will be removed and disposed of in advance of construction operations, but in the event there are improvements or other properties retained by the property owner, the Contractor shall not interfere with this property until notified in writing by the Engineer that the rights of the property owner have expired.

Delays in the work occasioned by removal or non-removal by the owner will be considered as attributable to the State under the provisions of the contract for the determination and extension of contract time, but any such delays shall not entitle the Contractor to nor shall such delays justify or be the basis for any monetary damages against the Commission, Department or any of its officers or employees.

Upon notification by the Engineer that the property owner's rights have expired, the Contractor shall proceed to remove and dispose of structures and obstructions in accordance with this subsection and other applicable provisions of the contract.

All existing structures and obstructions or residual portions of structures and obstructions not designated to remain are to be removed by the Contractor.

Improvements designated for removal are for the Contractor's information only, and the lack of such designation shall not relieve the Contractor of the removal

obligation.

When the contract documents indicate certain materials or other matter for removal or removal from the right-of-way permitted and disposed of at locations provided by the Contractor, the Contractor shall furnish the Engineer a copy of a release from each property owner for the servitude of the land. The Contractor shall also furnish the Engineer a certified letter stating that the area of disposal is not in a wetland. The State, the Commission, the Department, or any of its officers or employees will have no ownership or liability whatsoever for materials or matter removed thus from the right-of-way.

All removals by the Contractors are to be made in accordance with the provisions of Section 201, Section 202 and Section 203.

104.06--Use of Materials Found in the Work. It is understood that the title to all materials found within the right-of-way or easements remains with the State. However, the Engineer may permit the Contractor to use stone, gravel, sand and other suitable materials found within the grading limits that may be useful in fulfillment of the contract requirements. The Contractor will be paid both for the excavation of the material at the contract unit price for excavation and for the pay item for which the excavation material is acceptably used. The excavation material, so removed and needed for use in embankments, backfills, approaches, or otherwise in the work, shall be replaced by the Contractor with other material acceptable to the Engineer all at no additional cost to the State. No charge for the material so used will be made against the Contractor. The Contractor shall not excavate or remove any material from within the highway location which is not within the grading limits established by slope stakes without prior written authorization from the Engineer. The Contractor will not be paid for excavation outside the grading limits or below original ground in fill sections.

Unless otherwise provided, material removed from existing structures may be used temporarily by the Contractor. Material designated to be salvaged shall not be cut or otherwise damaged.

104.07--Final Cleaning Up. Before acceptance and final payment will be made, all areas within the right-of-way shall be cleaned of all rubbish, temporary buildings and structures, equipment and excess materials. Salvaged or excess materials expressly reserved by the Engineer for use by the State shall be neatly stockpiled at locations designated. All property occupied or affected by the Contractor and all parts of the work shall be left in a neat and manner acceptable to the Engineer with all waterways unobstructed.

Prior to final inspection for release of maintenance, all areas of the work which have developed an undesirable growth of vegetation shall be given a final mowing, and all undesirable bushes, high grasses and weeds shall be cut and disposed of as directed. The cost of mowing shall be absorbed in other contract

items when the contract does not contain a bid item for mowing and shall not be the basis for any additional payment.

104.08--Value Engineering Incentive. Value Engineering Incentive applies to any cost reduction proposal initiated and developed by the Contractor for the purpose of refining the contract documents so as to contribute to design cost effectiveness or significantly improve the quality of the final product. This subsection does not apply unless a proposal is identified by the Contractor at the time of submission as a Value Engineering Incentive Proposal. The Department shall be the sole judge of the acceptability of any such proposal and of the estimated net savings in construction costs from adoption of all or any part of such proposal.

Cost reduction proposals approved by the Department are to be implemented by a supplemental agreement to the contract and must result in savings without impairing any essential functions and characteristics such as safety, service life, reliability, economy of operations, ease of maintenance, aesthetics and necessary standard design features. Proposed changes in the basic design requirements of a bridge or of a pavement system will not normally be given consideration as a Value Engineering Incentive Proposal. The mere substitution of one contract bid item for another bid item or substitution of any other item for which the Department has previously established a pay item will not be allowed as value engineering nor will a submittal based on the use of material from the right-of-way.

As a minimum, the following information shall be submitted by the Contractor with each proposal:

- (a) A statement that the proposal is submitted as a Value Engineering Incentive Proposal.
- (b) Description of the proposal.
- (c) Discuss contract requirements which will require modification and present a recommendation for each change.
- (d) An estimate of cost reductions.
- (e) Prediction of any effects on other costs to the Department.
- (f) State when the supplemental agreement must be executed to obtain maximum cost reduction during the remainder of the contract and the reasons thereof.
- (g) A statement as to any effect on the project completion date.

The Commission, the Department or any of its officers or employees will not be liable for any delay in acting upon a proposal. The decision of the Engineer as to acceptance of any such proposal will be final and not be subject to Subsection 105.17. The Department may accept the proposal, in whole or in part, by executing a supplemental agreement which will specifically state that it is executed pursuant to these provisions. Such agreement will incorporate the changes or additions to the plans and specifications which are necessary to permit the proposal or accepted part thereof to be put into effect. If conditional, it will include conditions upon which the Department's approval is based. The agreement will also set forth the estimated net savings attributable to the proposal and will further provide that the Contractor be paid 50 percent of said savings. The cost to the Department in evaluating the proposal will be considered in determining the estimated net savings. The Contractor's share of the savings shall constitute full compensation for the Value Engineering Incentive Proposal.

Approval of the proposal and performance of the work thereof shall not change the contract completion date unless specifically provided for in the supplemental agreement implementing the proposal.

The Contractor may request that the Department not use or disclose the information submitted with a proposal and such request may be honored for the extent allowed by law. Such restriction must be in writing and submitted with the proposal. If the proposal is accepted, this restriction shall be void and the Department may use, duplicate or disclose any data necessary to utilize such proposal. The executed supplemental agreement implementing the proposal will become public information in the files of the Department.

This incentive provision applies only to contracts awarded pursuant to competitive bidding.

SECTION 105 - CONTROL OF WORK

105.01--Authority of the Engineer. The Engineer will decide all questions which may arise as to the quality and acceptability of materials, the work and the progress of the work; all questions which may arise as to the interpretation of the plans and specifications; and all questions as to the fulfillment of the contract.

The Engineer will have the authority to suspend the work wholly or in part and to withhold payments because of the Contractor's failure to correct conditions unsafe for workmen or the general public, for failure to carry out provisions of the contract, or for failure to carry out orders. The Engineer may also suspend work for periods deemed necessary due to unsuitable weather conditions, for any conditions considered unsuitable for the prosecution of the work, or for any other condition or reason deemed to be in the public interest.

The Engineer may authorize, in writing, the continued prosecution of items past

their specified seasonal limits when it is determined that the quality of the work will not be reduced and the public interest will be best served.

The Engineer will have authority to enforce and make effective all decisions and orders relating to the contract.

105.02--Plans and Working Drawings. After the contract is executed by the Executive Director, the Contractor will receive free of charge two bound copies of the proposal and contract documents, one executed and one blank, two full scale copies of the plans and five half-scale copies. The Contractor shall have one copy of the proposal and contract documents and one half-scale copy of the plans available at all times during work activity on the project.

Plans will generally show details of the work to be performed and a summary of the items appearing in the proposal.

The plans will be supplemented by working drawings as necessary to adequately control the work. Working drawings shall be furnished by the Contractor as required for the completion of the work. Except where otherwise specified, working drawings shall be approved by the Engineer but such approval will not relieve the Contractor of any responsibility. Working drawings shall not be considered as plan changes and any conflicts on working drawings, whether approved or not, shall not supercede the requirements of the original plans and specifications.

If required, the Contractor shall furnish the original tracings of working plans or drawings to the Engineer.

The contract price bid shall include the cost of furnishing all working drawings. However, when design details of the plans are changed after the Contractor has submitted the required working drawings, the Engineer may order the Contractor to furnish revised or new working drawings as Extra Work.

105.03--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, material requirements and other construction requirements shown on the plans or required by the specifications.

Plan dimensions and contract specification values are target values to be strived for and from which tolerances are allowed. It is the intent of the specifications that the materials and workmanship shall be uniform in character and shall conform as realistically as possible to the prescribed target value or to the middle portion of the tolerance range. The purpose of the tolerance range is to accommodate occasional minor variations from the median zone that are unavoidable for practical reasons. When maximum and/or minimum values are specified, the production and processing of the material and the performance of

the work shall be so controlled that the material and work will not be predominately of borderline quality or dimension. Predominantly borderline quality of materials or work on a continuing basis will be just cause for temporary suspension of work.

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 plans and specifications but that reasonably acceptable work has been produced, the Engineer will make a determination as to whether the work will be accepted and remain in place. The Engineer will then make an appropriate adjustment in the contract price for the work or materials as provided in the contract. If no provision for adjustment in price is included in the contract, the Engineer will document the basis of acceptance by contract modification and also may provide for an adjustment in contract price. The documentation will be based on Department SOP for adjustment in contract price or will be based on engineering judgment if a standard criteria for the items involved has not been issued.

When the materials, the finished product or the work are not in reasonably close conformity with the plans and specifications and have resulted in an inferior, unsatisfactory or unacceptable product, the work or materials shall be removed and replaced or otherwise corrected by the Contractor at no additional cost to the State in a manner satisfactory to the Engineer.

When work is of a temporary nature and its use is expected to be of short duration, the Engineer may allow minor deviations, not more than five percent (5%), from specified test values. Any such allowance will not relieve the Contractor from responsibility for maintenance of the work.

105.04--Coordination of Plans, Specifications, Interim Specifications, Special Provisions and Notice to Bidders. These specifications, interim specifications, plans, special provisions, notices to bidders and all other supplemental documents are essential parts of the contract, and a requirement occurring in one contract document is as binding as though occurring in all. They are intended to be complementary and provide for a complete work. In case of discrepancy, calculated dimensions will govern over scaled dimensions. The word "day" throughout the contract shall mean calendar days unless expressed otherwise. Parts of the contract will prevail in the following order:

- (a) Notices to Bidders
- (b) Supplements to Special Provisions and Supplements to Interim Specifications
- (c) Special Provisions
- (d) Interim Specifications
- (e) Plans
- (f) Standard Specifications and Supplemental Specifications

Any reference in the plans or contract documents to a particular Section or Subsection shall mean that Section or Subsection of the Mississippi Standard Specifications for Road and Bridge Construction , or that Section or Subsection as modified by the contract.

In case of conflict between a plan quantity and the advertisement and/or proposal, the plan quantity shall prevail unless otherwise noted in the contract documents.

The Contractor shall not take advantage of any apparent error or omission in the plans or specifications. When the Contractor discovers an error or omission, the Engineer shall be immediately notify. The Engineer will then make corrections and interpretations deemed necessary for fulfilling the intent of the contract.

105.05--Cooperation by Contractor. The Contractor shall give the work the attention necessary to expedite its progress, and shall cooperate with the Engineer, inspectors and other contractors in every possible way.

The Contractor shall have a competent and experienced full time resident superintendent who is capable of reading and understanding the plans and specifications for the particular work being performed. The superintendent shall receive instructions from the Engineer or authorized representative. Upon issuance of the Notice to Proceed, the Contractor or duly appointed agent authorized to bind the Contractor shall file with the Executive Director the name and address of the superintendent who will supervise the work with copies to the Construction Engineer, Contract Administration Engineer, District Engineer and Project Engineer. The Executive Director shall be immediately notified in writing with copies to those stated when a change is made in the Contractor's superintendent or superintendent's address. The superintendent shall have full authority to execute orders or directives of the Engineer without delay and to promptly supply materials, equipment, labor and incidentals as may be required. Such superintendence shall be furnished irrespective of the amount of work sublet.

The superintendent shall advise the Project Engineer of an intended absence from the work and designate a person to be in charge of the work during such absence.

The Contractor shall also designate a responsible person whose primary duty shall be to monitor and maintain the effectiveness of the erosion control plan, including NPDES permit requirements. The Engineer shall be furnished with the telephone numbers where the Contractor's responsible person and a substitute, authorized to act in the absence of the responsible person, may be reached at all times when not on the project. This in no way modifies the requirements regarding the assignment and availability of the superintendent.

105.06--Cooperation with Utilities. The Department will notify all utility

companies, all pipe line owners and other known affected parties and endeavor to have plans and agreements for all necessary adjustments within or adjacent to the limits of construction before bids are received. Such utility plans and agreements will be made available for inspection by the Contractor in the Jackson Office. The Department will also endeavor to have all necessary adjustments made as soon as practicable.

All utility appurtenances are to be relocated or adjusted by others unless provided otherwise in the contract.

All known utilities within the project are shown on the plans. It is understood and agreed that the Contractor's bid has considered all of the utility appurtenances in their present or relocated positions and that no additional compensation will be allowed for delays, inconvenience, or damage sustained by the Contractor due to interference from the said utility appurtenances or the operation of moving them. The Engineer's determination that removing, relocating, or adjusting of utility appurtenances or failure of others to do so is causing a delay in major phases of construction which normally should be in progress will be considered a delay by the State in the determination of extension of contract time, but any such delay shall not be the basis for any liability or monetary damage against the Commission, the Department or any of its officers or employees. In the event the utility owners fail to comply with their responsibility in relocating or adjusting their facilities, the Engineer may require the Contractor to make adjustments as Extra Work.

105.07--Cooperation Between Contractors. The Department reserves the right to award contracts for work on or near work covered by other contracts. Each Contractor will be expected to cooperate with the other Contractor(s) and the Department in every reasonable manner.

The Department will make a determination as to the practicality of prosecuting an existing contract before an additional award is made for work in the same area. Insofar as is practicable, the Department will give notice of the intent to award subsequent contracts in the same area. Failure to do so, however, shall not prejudice the rights of the Commission to award additional contracts and shall not constitute grounds for claims against the State, the Commission, the Department or any of its officers or employees.

When separate contracts are let for work, any part or all of which is within the same limits, each Contractor's work shall be conducted so as to cause the least interference with work being performed by the other Contractor(s).

When contracts are awarded to separate Contractors for concurrent construction within a common area, the Contractors, in conference with the Engineer, shall establish a written joint schedule of operations. Such schedule will set out approximate dates and sequences for work to be performed with due regard to

needs and contract time limitations of each contract. The Engineer may allow modification of the schedule when mutual benefit to the Contractors and the Department will result. Any modification of the joint schedule shall be in writing, mutually agreeable, and signed by the Contractors.

Failure of either Contractor to abide by the terms of the joint schedule or modified schedule will be justification for termination of the contract under the provision of Subsection 108.08.

Each Contractor's work shall be arranged such that the placement and disposal of the materials and equipment being used shall not interfere with the operations of the other Contractor. Each Contractor shall join their work with that of others in an acceptable manner and perform it in the sequence of the established schedule.

Each Contractor involved shall assume all liability, financial and otherwise, in connection with the contract and shall protect and save harmless the Commission, Department or any of its officers or employees from all damages or claims that may arise because of inconvenience, delay or loss experienced because of the presence and operations of the other Contractor(s) working within the same contract limits.

When the plans and/or proposal indicate a railroad crossing the project at grade, the Department intends to construct or have constructed by others an at-grade railroad crossing. This work may also include adjustment or installation of allied traffic safety features.

If the railroad work is to be performed under separate contract let by the Department, all the provisions of this subsection are applicable. When the work is to be performed by the railroad or its contractor, all the provisions of this subsection are applicable except a schedule of operations will not be required.

105.08--Construction Stakes, Lines and Grades. Except when the contract contains a pay item for "Roadway Construction Stakes," the Engineer will set construction stakes establishing lines, slopes, and profile grades in road work and only centerline and bench marks for bridge work. Box bridges shall not be considered as a bridge. The Engineer also will furnish the Contractor with all necessary information relating to lines, slopes, and grades. These stakes and bench marks shall constitute the field control by which the Contractor shall establish and maintain all necessary controls and perform the work.

The Department will assume responsibility for the accuracy of the stakes and bench marks at the time they are set by the Engineer or the Engineer's representative. Any corrective work caused by inaccurate field controls established by the Department will be considered as Extra Work and paid for under appropriate provisions of the Contract.

The Contractor shall be held responsible for the preservation of all stakes and bench marks, and when carelessly or willfully destroyed or disturbed, the cost of replacing them will be charged against the Contractor.

When the contract contains a pay item for construction stakes, Section 699 shall apply.

105.09--Authority and Duties of the Resident or Project Engineer. As the direct representative of the Chief Engineer, the assigned Resident or Project Engineer has immediate charge of the engineering details of the contract. The Resident or Project Engineer is responsible for the administration and satisfactory completion of the work in accordance with the contract, and the authority is delegated commensurate with these responsibilities.

105.10--Duties of the Inspector. Inspectors employed by the Department will be authorized to inspect all work and materials. The inspection may extend to all parts of the work and to the preparation, fabrication or manufacture of the materials. The inspector will not be authorized to alter or waive the provisions of the contract, to issue instructions contrary to the plans and specifications or to act as foreman for the Contractor.

105.11--Inspection of Work. All materials and each part or detail of the work are subject to inspection by the Engineer. The Engineer shall be allowed access to all of the work and shall be furnished with such information and assistance by the Contractor as necessary to make a complete and detailed inspection.

Prior to acceptance of the work, the Contractor shall remove or uncover such portions of the work as directed by the Engineer. After examination, the Contractor shall restore said portions of the work. If the work exposed or examined was acceptable, the uncovering or removing and the restoring of the work will be paid as Extra Work. If the work so exposed or examined was unacceptable, the uncovering or removing and the restoring of the work will be at no additional cost to the State or the Commission.

Work performed or materials used by the Contractor without supervision or inspection by an authorized Department representative may be ordered removed and replaced. In the event it is determined by the Executive Director that non-supervision or non-inspection by the Department was due to the failure of the Engineer to have a representative present after having been given reasonable notice in writing that the work was to be performed, the work may be examined, removed or replaced as ordered and will be paid as Extra Work if the work so exposed or examined was acceptable. Otherwise, such unauthorized work shall be removed and replaced at no additional cost to the State or the Commission.

When any unit of government, political subdivision, railroad corporation or other public service is to pay a portion of the cost of the work its respective representative shall have the right to inspect the work. Such inspection shall in

no way make said agency or corporation a party to this contract and shall in no way interfere with the rights of either party of the contract.

105.12--Removal of Unacceptable and Unauthorized Work. Unless otherwise determined acceptable under the provisions of Subsection 105.03, all work which does not conform to the requirements of the contract will be considered as unacceptable work.

Unacceptable work, whether the result of poor workmanship, defective materials, damage through carelessness or any other cause, found prior to final acceptance of the work shall be removed and replaced in an acceptable manner, without any additional cost to the Commission.

Work done contrary to the instructions of the Engineer, or beyond the lines shown on the plans or extra work without authority will not be paid for under the provisions of the contract.

105.13--Load and Speed Restrictions. The Contractor shall determine and comply with all legal load restrictions in the hauling of materials on public roads beyond the limits of the project. The Department shall not have any obligations to determine or inform the Contractor of any legal load limitations of any municipality, county or the State of Mississippi. A special permit will not relieve the Contractor of liability for damages which may result from the moving of material or equipment.

Within the project limits, the operation of equipment of such weight or so loaded as to cause damage to the roadway, structures or other work is forbidden. The Contractor shall regulate loads such that damage will not occur to structures or any completed subgrade or pavement structure, but in no case shall loads exceed the legal load limit. Loads will not be permitted on a portland cement concrete pavement, base or structure before the expiration of the curing period. The Contractor shall be responsible for all damages caused by hauling equipment .

The Contractor shall provide approved platform scales or a sufficient number of approved portable scales together with essentials for calibrating and all labor, tools, and equipment necessary to weigh as many loaded vehicles as will assure the Engineer of the Contractor's compliance with weight restrictions.

The Contractor shall be responsible for the safe speed of vehicles assigned to the project. Speeds less than those provided by law may be ordered in writing by the Engineer when in the opinion of the Engineer such action is essential to public safety or to the quality of work.

105.14--Maintenance During Construction. The Contractor shall maintain the work until released from maintenance. This maintenance shall constitute continuous and effective work prosecuted day by day with adequate equipment,

forces and material to the end that the roadway structures and all other features of the work are kept in satisfactory condition at all times. Traffic shall be continuously, safely and conveniently maintained as required under the contract.

In the case of a contract for the placing of a course upon a course or subgrade previously constructed, the Contractor shall maintain the previous course or subgrade during all construction operations.

All cost for maintenance of the work shall be included in the unit prices bid on the various pay items, and the Contractor will not be paid any additional amount for such work except as otherwise provided in the contract.

105.15--Failure to Maintain Roadway or Structures. If the Contractor, at any time, fails to comply with the provisions of Subsection 105.14, the Engineer will immediately notify the Contractor of such non-compliance. When the deficiency creates a traffic hazard, the Contractor shall immediately use all available means to correct or otherwise remove the hazard. The Contractor's failure to remedy unsatisfactory maintenance within 24 hours after receipt of such notice will be just cause for the Engineer to maintain the project with such forces as the Engineer deems necessary. Any and all cost to the State or Commission will be deducted from monies due or to become due the Contractor.

105.16--Acceptance.

105.16.1--Partial Acceptance. When the Contractor has completed a unit of the work such as an interchange, a structure, a portion of the road or pavement or one project of a multi-project contract, the Contractor may request the Engineer to make a final inspection of that unit; or the Executive Director may order a final inspection of the unit if it is in the public's interest. If the Engineer finds upon inspection that the unit has been completed in compliance with the contract and it is a complete facility which can be made available to the public or made available for the prosecution of work under another contract, the Executive Director may conditionally accept the unit and conditionally relieve the Contractor of certain contractual responsibilities as defined in the release.

In the event items of work covered by such release are found to be defective or deficient as evidenced by unsatisfactory test reports of materials incorporated in the work or other engineering determination, the release shall terminate upon written notification to the Contractor. The Contractor shall make all corrections, restorations, constructions or reconstructions deemed necessary and shall resume all contractual responsibilities until all corrective measures have been made in accordance with the terms of the contract.

Partial acceptance does not constitute final acceptance of the work, or any part thereof, nor in any way void or alter any of the terms of the contract.

Relief from "certain contractual responsibilities" as indicated herein may, or may not, include:

- (a) Further maintenance of the defined limits of the partially accepted work.
- (b) Further public liability for the defined limits of the partially accepted work.
- (c) Further liability for liquidated damages as applicable to the value of the partially accepted work when the quantities for the partially accepted work are separate quantities listed on the Summary of Quantities sheet of the plans, and the separate quantities and the total amounts thereof are listed on the Engineer's Estimate. Otherwise, no reduction in liquidated damages will be made because of such partial acceptance.

Unless specifically provided in the contract, the liability for liquidated damages shall not be reduced to less than that applicable under the contract for an amount of such work equal to at least fifty percent (50%) of the total amount of work under the contract.

105.16.2--Final Acceptance. Upon written notice from the Contractor of presumptive completion of all the work and upon due notice from the Resident or Project Engineer, the Engineer will make an inspection. If all work provided by the contract has been completed to the Engineer's satisfaction, that inspection will constitute the final inspection, and the Engineer will conditionally release the Contractor of maintenance and notify the Executive Director of completion. Upon evidence that the Contractor has fulfilled all obligations under the contract, the Executive Director will make final acceptance and notify the Contractor in writing. On applicable Federal Aid projects, form FHWA-47 must be completed and submitted to the Project Engineer within 45 days of the final inspection.

If the inspection discloses any work as being unsatisfactory or incomplete, the Engineer will discuss in detail with the Contractor all discrepancies in the work. Upon correction of the work, another inspection will be made which shall constitute the final inspection provided the work has been satisfactorily completed and the Engineer will notify the Executive Director as to said completion. Upon evidence that the Contractor has fulfilled all obligations under the contract, the Executive Director will make final acceptance and notify the Contractor in writing.

However, if during the final inspection the Engineer determines that all work has been satisfactorily completed save that of growth and coverage of plant establishment on all or part of the work, the Engineer may recommend acceptance of all work except items related to growth and coverage. Upon such recommendation the Contractor may be released of maintenance and further contractual liabilities for the completed work. The Contractor will retain responsibility for plant establishment and all maintenance and repairs appurtenant thereto until satisfactory growth and coverage is achieved.

105.17--Claims for Adjustments and Disputes. It is in the public interest that the Department have early or prior knowledge of an existing or impending claim of any nature by the Contractor so that the Department may appropriately consider modifying the details of the work or other actions of the Department which might result in mitigation or elimination of the effect of the act or conditions objected to by the Contractor and so that the Department may institute appropriate procedures, as required, to keep strict account of actual costs and to verify, at the time, facts upon which a claim is made. Therefore, if in any case the Contractor deems that additional compensation is due for work or materials not covered in the contract or not ordered by the Engineer as Extra Work, or if the Contractor deems that adjustment in the contract time should be made because of any of the reasons provided for in the contract as a basis for an extension of time, the Contractor shall immediately notify the Engineer in writing of an intention to make such claim for additional compensation before beginning the work on which the Contractor bases the claim. If the nature of the claim is such that the Contractor can not fully identify all aspects of the claim, the Contractor shall have 30 calendar days from the date of the incident to provide the Engineer with written documentation clearly identifying the claim issue(s) and all other logically related work items or phases. If such written notification is not given by the Contractor in accordance with these specifications and the Engineer and the Department's Audit Division, or other authorized persons, are not afforded proper facilities by the Contractor for keeping strict account of actual costs or verification at the time of facts upon which a claim for contract adjustment is made, the Contractor hereby agrees that failure to provide written notice has denied the Department the prerogative of verifying additional time, materials, equipment, labor and making adjustments in the work which might remove or alleviate the conditions for which a claim might be made, and the Contractor further agrees that such failure on the Contractor's part shall be a conclusive waiver of any claim, or part thereof, including the waiver of any such claim for damages before a court of law.

Mere oral notice or statement will not be sufficient, nor will an unnecessarily delayed notice or statement after the event.

Any such notice shall be in writing on a form provided by the Department for such purpose and shall describe in detail any act of omission or commission by the Department or its agents that allegedly caused or contributed to the condition for which a claim may be made and the nature of the claim and shall provide all documentation to support any such claim. The Contractor shall deliver or mail the notice to the Project Engineer and retain proof of such delivery.

Upon receipt of the notice, the Project Engineer will acknowledge receipt in writing to the Contractor with a copy of the notice and acknowledgment to the District Engineer, State Construction Engineer and the Department's Audit Director.

The Project Engineer will evaluate the Contractor's claim and forward recommendations to the District Engineer with a copy to the State Construction Engineer and the Department's Audit Director.

The State Construction Engineer, after consultation with the District Engineer and Project Engineer, will notify the Audit Division of the Contractor's claim and request that the Audit Director, and/or other appropriate individual, take the necessary steps to review the legitimacy of the Contractor's documentation of the claim.

Audit Division determines that the Contractor's documentation relative to the time, materials, equipment and labor may be legitimate, that division or other appropriate individual will continue to monitor the Contractor's charges until the Contractor's services are complete.

The Contractor agrees that such notice by the Contractor and that the Engineer has kept account of the costs and the Audit Division or other authorized individual has considered the legitimacy of the Contractor's documentation and other facts as aforesaid shall not in any way be construed as substantiating the validity of a claim.

In presenting a claim, the Contractor shall clearly and specifically state:

- (a) The contract subsection number(s) under which each part of the claim is made.
- (b) The event(s) or conditions covered in each such subsections and made the basis for each part of the claim.
- (c) A claim for additional compensation shall include supporting auditable cost figures from entries made in the original records entered at the time of the work. The Contractor agrees to and will be required to provide all records that the Department's Audit Director or other appropriate individual deems necessary for the performance of an audit in accordance with the United States General Accounting Office's Governmental Auditing Standards, the Institute of Internal Auditor's Professional Practice Standards, and the American Institute of Certified Public Accountant's Auditing Standards.

All claims made shall be sent to the Resident or Project Engineer for review and appropriate action.

The Contractor agrees that if a claim is so vague that the Engineer cannot reasonably and expeditiously determine the specific contractual provisions relied on by the Contractor as the basis of each part of the claim, or if the Audit Director or other appropriate individual cannot reasonably and expeditiously determine that the costs related to the claim are related specifically to the referenced project or are not related to any other project(s) that the Contractor is

constructing or has constructed, it will be denied by the Engineer or returned without action.

Any part of a claim based on after-the-fact general statements of costs such as "Normal cost of such work", "computed as a percentage of etc." or other such indefinite statements shall not justify or be the basis for the payment of or award of any damages and will be denied or returned to the Contractor without action.

The Resident or Project Engineer may request supplemental data in writing, or return the claim to the Contractor for resubmission in accordance with these specifications.

A claim, as approved by the Department, will be paid in accordance with the provisions of Subsections 104.02 and 104.03 and adjustments in contract time will be made in accordance with the provision of Subsection 108.06. When a claim is denied or returned without action, the notice will state the reasons thereof.

105.18--Automatically Controlled Equipment. Unless otherwise prohibited in other sections of the specifications or other contract documents, automatically controlled equipment that malfunctions may be operated manually or by other approved methods for a period of time approved by the Engineer so as to prevent loss or damage to the work already produced, manufactured, or processed at the time of the breakdown or malfunction. The resulting work must meet the requirements of the contract.

SECTION 106 - CONTROL OF MATERIALS

106.01--Source of Supply and Quality Requirements.

106.01.1--General. The materials used in the work shall meet all quality requirements of the contract. At the option of the Engineer, materials may be approved at the source of supply provided the Contractor notifies the Engineer of the proposed source of material well in advance of the time of proposed delivery. If previously approved materials do not produce uniform and satisfactory products, the Contractor shall furnish materials from other sources.

106.01.2--Warranties, Guaranties, Instruction Sheets and Parts Lists. For manufactured articles, units, components or materials incorporated in any mechanical or electrical facility required under the contract, the manufacturer's warranties, guaranties, instruction sheets and parts lists shall be delivered before final acceptance of the work.

106.02--Local Materials Sources.

106.02.1--Designated Sources. Possible sources of local material may be designated on the plans or described in the special provisions. The quality of material in such deposits will be acceptable in general, but the Contractor shall determine for himself the equipment and work required to produce uniform, acceptable material. It shall be understood that it is not feasible to ascertain from samples the specific limits of acceptable material from the entire deposit and variations shall be considered as usual and are to be expected. The Engineer may order procurement of material from any portion of the deposit and may reject other portions of the deposit as unacceptable.

Unless designated sources are identified in the contract as State Furnished or State Optioned, acquisition and rights of ingress and egress shall be the responsibility of the Contractor.

106.02.2--Contractor Furnished Sources. The Contractor shall provide sources of materials meeting the requirements of the contract and shall bear all costs involved, including the cost to the Department for sampling and testing for source approval.

The Department's costs will be based on the standard sampling and testing charges published in Department SOP, and the charges will be deducted from monies due the Contractor.

The Department will assume the cost of acceptance sampling and testing during production and use of the materials.

All pits and quarry sites are subject to approval from the Mississippi Department of Environmental Quality, Office of Geology, as set forth in Subsection 107.23.

106.02.3--All Sources. All pit operations including hauling shall comply with the applicable provisions of Subsection 107.22. Unless otherwise permitted, all pits shall be drained upon completion.

106.03--Samples, Tests, and Cited Specifications. All materials used in the work shall conform to the general requirements of Section 700 and the specific requirements for each item of work. Cited specifications of AASHTO, ASTM or Federal Specifications for materials or test methods shall be understood to mean approved pre-published or published "Standards" of ASTM, AASHTO, Federal Specifications; Interim Specifications of AASHTO denoted by the suffix "I", Tentative Specifications of ASTM denoted by the suffix "T", or amended Federal Specifications denoted by a numbered amendment, current on the date of advertisement for bids. Unless otherwise provided, all materials shall be inspected and tested for acceptance in accordance with Subsection 700.03. The work shall be considered incomplete until acceptance of all materials used in the work. Any work performed prior to approval of materials will be the sole responsibility of the Contractor.

The Department reserves the right to retest all materials even though they have been tested and approved earlier and to reject all retested materials that do not meet the requirements of the contract.

Prior inspection, test and approval of material used as a component of another item of work shall in no way imply acceptance if the work in which the material is incorporated fails to meet the requirements of the contract.

Test reports will be furnished to the Contractor upon request.

106.04--Certification of Compliance. Prior to sampling and testing by the Department, the Engineer may permit use of certain materials or assemblies accompanied by acceptable certificates of compliance stating that such materials or assemblies fully comply with the requirements of the contract. Each lot of such materials or assemblies delivered to the work must be accompanied by an approved certificate of compliance in which the lot is clearly identified.

Certificates of Compliance shall be prepared in accordance with Subsection 700.05.

Materials and assemblies used on the basis of Certificates of Compliance and found not to be in conformity with contract requirements are subject to rejection whether in place or not.

Unless otherwise required, the original and three copies of all Certificates of Compliance shall be furnished to the Engineer. Unless specifically provided for elsewhere in the Contract, payment for the work will not be made until proper certification has been received.

106.05--Plant Inspection. The Engineer may make the inspection at the source of material produced by a third party.

In the event such plant inspection is undertaken the following conditions shall be met:

- (a) The Engineer shall have the cooperation and assistance of the Contractor and the producer.
- (b) The Engineer shall have full entry of the plant as may concern the manufacture or production of the materials.
- (c) When specified, the Contractor shall provide an approved laboratory unit conforming to the applicable requirements of Section 621.

106.06--Blank.

106.07--Foreign Materials. Except as specifically prohibited in these specifications or other contract documents, consideration may be given by the Department to the use of certain materials manufactured or produced outside of the United States provided the materials are delivered to approved locations within the State. The Contractor shall, at no additional cost to the State, arrange for any required sampling and testing which the State is not equipped to perform. All testing shall generally be performed within the United States' Mainland and be subject to witnessing by the Engineer. Certain materials or processes may necessitate the testing be performed or witnessed at the foreign source by State personnel. When the Engineer authorizes inspection at a foreign site, the Contractor shall reimburse the State for all expenses incurred outside the United States by the State's representatives.

For materials requiring mill test reports, the State Materials Engineer will determine that in-plant quality controls are adequate to assure delivery of uniform material in accordance with contract requirements, and the State Materials Engineer's determination of the adequacy of in-plant quality controls with respect to mill test reports and certificates of compliance shall be final.

No structural materials will be accepted which cannot be properly identified with mill test reports and certificates of compliance even though in-plant quality control procedures have been established to the satisfaction of the State Materials Engineer.

106.08--Storage of Materials. Materials shall be stored in a manner to assure the preservation of their quality and fitness for the work. Stored materials may be re-inspected and retested prior to their use in the work. The materials shall be located so as to facilitate their prompt inspection. Approved portions of the right-of-way may be used for plant operation and storage of materials and equipment. Private property shall not be used without written permission of the owner or lessee, and duplicate copies of such written permission shall be furnished the Engineer. All sites shall be restored to their original conditions at no additional cost to the State or the Commission. This shall not apply to stripping and storing of materials salvaged from the work for use by the Department on other work.

106.09--Handling Materials. All materials shall be handled in such manner as to preserve their quality and fitness for the work. Materials shall be transported in tight vehicles so constructed as to prevent loss or segregation of materials after loading and measuring for incorporation in the work.

106.10--Unacceptable Materials. All materials not conforming to the requirements of the specifications at the time they are incorporated in the work shall be rejected and removed immediately unless otherwise instructed by the Engineer. Rejected materials which have been corrected shall not be used until written approval has been given by the Engineer.

106.11--Department Furnished Material. Material furnished by the Department will be delivered or made available to the Contractor at the points specified in the contract.

Unless otherwise specified, the cost of handling, placing, and maintaining all materials after they are delivered or made available will be at the Contractor's expense.

The Contractor will be held responsible for all materials delivered or made available and deductions will be made from monies due for shortages or deficiencies, damages which may occur thereafter, and any demurrage charges.

106.12--Substitute Materials. The Contract will typically specify material generally used in highway construction. The Department from time to time will approve substitute materials for specific uses. These materials and their uses will be noted on the Department's "List of Approved Materials". Contractors proposing to use substitute materials will be responsible for determining if the material has gained Department approval. When an approved substitute material is to be used, the Contractor will furnish a certification from the manufacturer that the product is the same material as approved by the Department and that no alterations have been made. Material will be sampled and tested by the Department as necessary for acceptance. Approved lists may be obtained from the State Materials Engineer.

106.13--Convict Produced Materials. Materials produced after July 1, 1991, by convict labor may only be incorporated in a Federal-Aid highway construction project if such materials have been:

- (1) Produced by convicts who are on parole, supervised release, or probation from a prison or
- (2) Produced in a qualified prison facility and the cumulative annual production amount of such materials for use in Federal-aid highway construction does not exceed the amount of such materials produced in such facility for use in Federal-Aid highway construction during the 12-month period ending July 1, 1987.

Qualified prison facility means any prison facility in which convicts, during the 12-month period ending July 1, 1987, produced materials for use in Federal-Aid highway construction projects.

SECTION 107 - LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

107.01--Laws to Be Observed. The Contractor shall have the authority to and will keep fully informed and comply with all Federal, State and local laws,

ordinances, regulations and all orders and decrees of bodies or tribunals having jurisdiction or authority which affect those engaged or employed on the work or affect the conduct of the work. The Contractor shall protect and indemnify the State and its representatives against all claims or liability arising from or based on the violation of such laws, ordinances, regulations, orders or decrees whether by the Contractor, the Contractor's employees, subcontractors and employees or agents thereof.

107.02--Permits, Licenses, and Taxes. The Contractor shall have the duty to determine any and all permits and licenses required and to procure all permits and licenses, pay all charges, fees and taxes and issue all notices necessary and incidental to the due and lawful prosecution of the work.

The Contractor is advised that the "Mississippi Special Fuel Tax Law", Section 27-55-501, et seq. and its requirements and penalties apply to any contract for construction, reconstruction, maintenance or repairs, for contracts entered into with the State of Mississippi, any political subdivision of the State of Mississippi, or any Department, Agency, Institute of the State of Mississippi or any political subdivision thereof.

The Mississippi State Tax Commission will be notified of the name and address of Contractors that are awarded MDOT contracts. The Contractor will be subject to an audit during the life of this contract to make certain that all applicable fuel taxes are being paid promptly as outlined in Section 27-55-501, et seq.

107.03--Patented Devices, Materials, and Processes. If the Contractor employs any design, device, material or process covered by letters of patent or copyright, the Contractor shall provide for such use by agreement with the patentee or owner. The Contractor shall not involve the State or the Commission in the payment for royalties, either directly or indirectly. Attention is invited to Section 65-1-61, Mississippi Code of 1972, Annotated, regarding use of patented materials for paving. At any time during the prosecution or after completion of the work, the Contractor and Surety shall indemnify and save harmless the State and/or the Commission, any affected third party or political subdivision from any and all claims for infringement by use of any such patent or copyright.

107.04--Restoration of Surfaces Opened by Permit. The right to construct or reconstruct any utility service in the highway or street or to grant permits for same, at any time, is expressly reserved by the Department. The Contractor will not be entitled to any damages from the Commission or the Department for delays or damages due to utility construction or reconstruction by a third party except an adjustment in contract time will be allowed when the Engineer determines a delay prevents the performance of the controlling phase(s) of work.

Any individual, firm or corporation wishing to make an opening in the highway must secure a permit from the Department. The Contractor shall allow parties

bearing approved permits or agreements, and only those parties, to make openings in the highway. When ordered by the Engineer, the Contractor shall make all necessary repairs and will be paid as provided in these specifications or as Extra Work. The repairs will be subject to the same requirements as the original work.

107.05--Federal Aid Participation. When the United States Government pays all or any portion of the cost of a project, the Federal laws and the rules and regulations made pursuant to such laws shall be observed by the Contractor, and the work shall be subject to the inspection of the Federal agency.

Such inspection shall in no way make the Government a party to this contract nor will it interfere with the rights of either party hereunder.

107.06--Sanitary, Health and Safety Provisions. The Contractor shall provide and maintain adequate sanitation facilities for employee use. The location of such accommodations shall be subject to the prior approval of the Engineer. The Contractor shall also provide adequate dust control on the project, haul roads and at other areas of operation.

Such accommodations shall be designed and operated to conform to local and State health regulations. The Contractor shall not require any worker to work in surroundings or under conditions contrary to local, State, and Federal health and safety regulations. All such requirements and regulations shall be as binding upon the Contractor as actually included in these specifications.

No direct payment will be made for these provisions.

107.07--Public Convenience and Safety. The Contractor shall conduct work in a manner to assure the least possible obstruction to traffic. The safety and convenience of the general public, residents along the highway and protection of persons and property shall be provided as specified under Subsection 104.04.

All work on grade separation structures, such as overpasses or underpasses of existing highways, roads or streets, shall be in a manner to assure the least practicable interference with the public use of the facility. The Contractor shall use reasonable care and precaution to avoid accidents, damage, unnecessary delay or interference with traffic and provide competent flaggers to insure maximum public safety.

107.08--Railway-Highway Provisions. The Department will obtain railroad agreements as required by the contract. The agreements will be available for the bidder's review in the Office of the Bridge Engineer when the railroad is at bridge sites, and the District Office for at-grade railroad crossings.

107.08.1--Authority of Railroad Engineer and Highway Engineer. The

authorized representative of the railroad, hereinafter referred to as the Railroad Engineer, shall have final authority in all matters affecting the safe maintenance of railroad traffic including the adequacy of the foundation and structure supporting the railroad tracks.

The authorized representative of the Department, hereinafter referred to as the Engineer, shall have authority over all other matters.

107.08.2--Notice of Starting Work. The Contractor shall not commence any work on railroad rights-of-way until the following conditions have been met:

- (a) Give the Railroad Company written notice with a copy to the Engineer at least ten days in advance of the proposed date to begin work on railroad rights-of-way.
- (b) Obtain from the Railroad Company, written approval of Liability Insurance as required by Subsection 107.14.2.2.
- (c) Obtain written authorization from the Railroad Company to begin work on railroad rights-of-way. Such authorization may include specific conditions.
- (d) Before commencing work on any pier or structure adjacent to any track, the Contractor shall submit to the Engineer for the approval of the Engineer and Railroad Engineer, seven prints of the proposed sheeting and bracing details and method of installation for protection of the railroad embankment and tracks. These plans shall bear the seal of a registered structural or professional engineer and shall be accompanied by design computations and soil data pertinent to the site, or other acceptable basis used for the design. During construction, the Contractor shall make provisions satisfactory to the Engineer and Railroad Engineer against disturbing, in any manner, the railroad embankment or track(s).

The Railroad Company's written authorization to proceed with the work should include the name, address and telephone number of the railroad's representative to be notified in advance of the work. Where more than one representative is designated, the area of responsibility of each representative should be specified.

107.08.3--Interference with Railroad Operations. The Contractor shall so arrange and conduct the work in such a manner that there will be no interference with railroad operations, including train, signal, telephone and telegraphic services, or damage to the property of the Railroad Company or to poles, wires and other facilities or tenants on the rights-of-way of the Railroad Company. Whenever work is likely to affect the operations or safety of trains, the method of doing such work shall first be submitted to the Railroad Engineer for approval, but such approval shall not relieve the Contractor from liability. Any work to be

performed by the Contractor which requires protective service (flagging or inspection) shall be deferred by the Contractor until the protective service is available at the job site.

When work within railroad rights-of-way is of such a nature that interference to railroad operations is unavoidable, the Contractor shall schedule and conduct the work so that such interference is held to a minimum.

Should conditions arise from the work that require immediate and unusual provisions be made to protect operations and property of the railroad, the Contractor shall provide such provisions. When these provisions are insufficient in the judgment of the Railroad Engineer or the Engineer in the absence of the Railroad Engineer, the Contractor shall provide such provisions as deemed necessary. Any such unusual provisions shall be without cost to the railroad.

107.08.4--Track Clearances. Unless written authorization to the contrary is obtained from the Railroad Engineer, the minimum track clearances listed below or as shown on the plans, whichever is greater, shall be maintained by the Contractor at all times during construction operations:

Vertical: 21' 6" above the top of highest rail
Horizontal: 14' 0" from centerline of nearest track, measured at right angles thereto.

However, before undertaking any work within railroad rights-of-way or before placing any obstruction over any track, the Contractor shall:

- (a) Notify the railroad's representative at least 72 hours in advance of the work.
- (b) Receive assurance from the railroad's representative that arrangements have been made for any required flagging service.
- (c) Receive permission from the railroad's representative to proceed with the work.
- (d) Ascertain that the Engineer has received copies of notice to the railroad and the railroad's response.

107.08.5--Construction Procedures.

107.08.5.1--General. Construction work on railroad property shall be subject to the inspection and approval of the railroad representative and in accordance with the railroad's outline of specific conditions and these specifications.

107.08.5.2--Excavation. The subgrade of an operated track shall be maintained with edge of berm at least 10'0" from centerline of track and not more than 24 inches below top of rail. If existing track section is substandard, the Contractor will be required only to maintain the existing section.

107.08.5.3--Excavation for Structures. When excavating and/or driving piling adjacent to tracks, the Contractor shall take special precaution and care to provide adequate lateral support for the tracks and the loads which they carry, without disturbance of track alignment and grade, and to avoid obstructing track clearances with equipment, tools, or materials. The procedure for doing such work, including need of and plans for shoring, shall be approved by the Railroad Engineer, but such approval shall not relieve the Contractor from liability.

107.08.5.4--Blasting. The Contractor shall obtain advance approval of the Railroad Engineer and the Engineer for use of explosives on or adjacent to railroad property. If permission is granted, the Contractor will be required to comply with railroad requirements and the following:

- (a) Blasting shall be done with light charges under the direct supervision of a responsible officer or employee of the Contractor.
- (b) Electric detonating fuses shall not be used because of the possibility of premature explosions resulting from operation of two-way radios.
- (c) No blasting shall be done without the presence of an authorized representative of the railroad. At least 72 hours advance notice to the person designated in the railroad's notice of authorization to proceed will be required to arrange for the presence of an authorized railroad representative and such flagging as the railroad may require.
- (d) The Contractor shall have at the job site adequate equipment, labor and materials and allow sufficient time to clean up debris resulting from the blasting without delay to trains, and correct any track misalignment or other damage to railroad property as directed by the railroad's authorized representative. Cost for delay of trains caused by the Contractor's actions shall be borne by the Contractor.

The railroad representative will determine the approximate location of trains and advise the Contractor of the approximate amount of time available for the blasting and clean-up operation. The representative will have the authority to order discontinuance of blasting if blasting is too hazardous or is not in accord with these specification.

107.08.5.5--Maintenance of Railroad Facilities. The Contractor shall maintain all tracks, railroad beds, ditches and drainage structures free of silt or other obstructions, promptly repair eroded areas within railroad rights-of-way, and be responsible to the railroad for repair to any other damage to the property of the railroad or its tenants which is a direct result of the Contractor's operations.

107.08.5.6--Storage of Materials and Equipment. The Contractor shall not store materials and equipment on the rights-of-way of the Railroad Company without obtaining written permission from the Railroad Engineer. Such permission may be with the understanding that the Railroad Company will not be liable for any damages to materials and equipment from any cause and that the

Railroad Engineer may move or require the Contractor to move such materials and equipment.

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

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

107.08.6--Damages. The Contractor shall assume liability for damages to the work, the Contractor's employees, servants, equipment and materials caused by railroad traffic unless such damages result from negligent operation of the railroad.

Any cost incurred by the railroad for repairing damages to railroad property or to property of railroad tenants caused by or resulting from the Contractor's operations shall be the responsibility of the Contractor.

107.08.7--Flagging Services.

107.08.7.1--When Required. The Railroad Engineer has sole authority to determine the need for flagging. Generally, the requirement of this service will be when Contractor's personnel or equipment are, or are likely to be, working on the railroad's rights-of-way or when the work is likely to disturb a railroad structure, roadbed or grade and alignment of any track to such extent that the movement of trains must be controlled or when booming over track(s) with a crane.

107.08.7.2--Scheduling and Notification. Not later than the time that approval is initially requested to begin work on railroad rights-of-way, the Contractor shall furnish to the railroad and the Department a schedule for all work required to complete the portion of the project within railroad rights-of-way and arrange for a job site meeting between the Contractor, the Department, and the railroad's authorized representative. Work on railroad rights-of-way shall not begin until the job site meeting has been conducted and the Contractor's work scheduled.

The Contractor is to give the railroad representative at least ten days of advance written notice of intent to begin work within railroad rights-of-way in accordance with these specifications. If work is suspended, the Contractor shall give the

railroad representative at least three days of advance notice before resuming work. Such notices shall include sufficient details of the proposed work to enable the railroad representative to determine if flagging will be required. If such notice is in writing, the Contractor shall furnish the Engineer a copy or if notice is given verbally it shall be confirmed in writing with copy to the Engineer. If flagging is required, no work shall be undertaken until the flagger/flaggers is/are present at the job site.

If, after the flagger is assigned to the project site, emergencies arise which require the flagger's presence elsewhere, the Contractor shall delay work on railroad rights-of-way until such time that a flagger is available.

107.08.7.3--Payment. The Department will be responsible for reimbursement to the railroad directly for any and all costs for flagging and inspection services which are required to accomplish the work required by the contract.

107.08.8--Haul Across Railroad. Where the plans show or imply that materials must be hauled across a railroad, the Contractor will be required to make all necessary arrangements with the railroad regarding means of transporting such materials unless the plans clearly show that the Department has included arrangements for such haul in its agreement with the railroad. The Department will reimburse the railroad for cost of flagging, and the Contractor will be required to bear all other costs incidental to such crossings whether services are performed by the Contractor or by railroad personnel.

No crossing may be established for transporting materials or equipment across a railroad unless specific authority for its installation, maintenance, protective services and removal is first obtained from the Railroad Engineer.

107.08.9--Railroad Services for Benefit of the Contractor. Railroad services (including flagging and inspection) needed for any work which is for benefit of the Contractor or due to work which is the fault of the Contractor shall be at the Contractor's expense. The Contractor shall make specific arrangements for such work including basis of payment with the railroad. Prior to final acceptance, the Contractor shall furnish to the Department satisfactory evidence that the railroad has acknowledged receipt of payment for any such services.

107.08.10--Cooperation and Delays. It shall be the Contractor's responsibility to arrange a schedule with the railroad for accomplishing stage construction involving work by the railroad or tenants of the railroad. In arranging the schedule, the Contractor shall ascertain, from the railroad, the lead time required for assembling crews and materials and make due allowance.

No charge or claims of the Contractor against either the Department or the Railroad Company will be allowed for hindrance or delay on account of railroad traffic, work by the Railroad Company or other delays incident to or necessary

for safe maintenance of railroad traffic or any delays due to compliance with these specifications.

107.08.11--Trainman's Walkways. Along the outer side of each exterior track of multiple operated track and on each side of single operated track, an unobstructed continuous space suitable for trainman's use in walking along trains, extending to a line not less than ten feet from centerline of track, shall be maintained. Any temporary impediments to walkways and track drainage encroachments or obstructions allowed during work hours while railroad's protective service is provided shall be removed before the close of each work day. If there is any excavation near the walkway, a handrail with ten foot minimum clearance from centerline of track shall be installed.

107.08.12--Insurance. The Contractor shall be required to carry insurance in accordance with Subsection 107.14.2.

107.08.13--Failure to Comply. In the event the Contractor violates or fails to comply with any of the requirements of these specifications, the Railroad Engineer may require that the Contractor vacate railroad property. Any such orders shall remain in effect until the Contractor has remedied the situation to the satisfaction of the Railroad Engineer and the Engineer.

107.09--Construction Over or Adjacent to Navigable Waters and Wetlands. All work on, over or adjacent to navigable waters or wetlands shall be conducted in accordance with permit issued by the controlling authority.

The Department will obtain permits for work over navigable waters and wetlands, and bidders are advised to closely examine the provisions of such permits relative to spoil disposal and water quality considerations and the necessary construction of retention basins, settling ponds, temporary navigation lights, etc. Copies of the permits will be included in the contract documents or available for review at the Jackson and District Offices of the Department.

The Contractor shall conform with all provisions and conditions of the permits.

The permits will only cover work shown on the plans. Should temporary construction be proposed for the Contractor's convenience in the areas set out in the permits, the Contractor shall apply for and furnish a copy of the required permits to the Engineer before proceeding with the temporary construction.

107.10--Barricades, Warning Signs and Flaggers. The Contractor shall provide, erect and maintain all necessary barricades, lights, danger signals, signs and other traffic control devices; shall provide qualified flaggers where necessary to direct the traffic; and shall take all necessary precautions for the protection of the work and the safety of the public. Highways or parts of the work closed to through traffic shall be protected by effective barricades. Suitable warning signs

shall be provided to properly control and direct traffic.

The Contractor shall erect warning signs in advance of all places on the project where operations may interfere with traffic and at all intermediate points where the work crosses or coincides with the existing roadway. Such warning signs shall be constructed and erected in accordance with the provisions of the contract.

All barricades, warning signs, lights, temporary signals, other protective devices, flaggers and signaling devices shall meet or exceed the minimum requirements contained in the MUTCD which is current at the time bids are received.

All traffic control devices on an existing highway, road or street are understood to be public property under the provisions of Subsection 107.12.

On all sections of a project which are coincident with an existing highway, road, or street and open to traffic, the Contractor shall be fully responsible for the protection, maintenance, and replacement of all existing signs, route markers, traffic control signals, and other traffic service features from the beginning of contract time or beginning of work, whichever occurs earlier, until final completion of the work.

The Contractor shall restore or replace in kind, under the provisions of Subsection 107.12, all devices damaged, destroyed or lost by the Contractor.

On or about the effective date of the Notice to Proceed, the Engineer will make an inventory of all traffic service devices with adequate description of each sign, post, message, signal and other devices as a basis for replacement in kind. A copy of the inventory, dated, identified, and signed will be forwarded to the District and Contractor.

Near completion of the work, the Engineer will make another inventory of the traffic control devices and distribute as indicated for the earlier inventory. A list and detail description of the traffic control devices which have been damaged, destroyed or lost and must be replaced in kind by the Contractor will be attached to the inventory. The Engineer will confirm in writing the completion of sign replacement by the Contractor.

Prior to performing work on the project, the Contractor shall make the necessary arrangements to prevent damage or loss of signs and other traffic control devices. Those which cannot be left in their existing positions shall be removed, stored, or reinstalled at locations approved by the Engineer. As soon as work which conflicted with the original position of each device has been performed, the device shall be reinstalled at the original position or modified position as approved by the Engineer.

The Contractor shall maintain in position only those signs that are appropriate for

existing conditions and those that are not or have served their purpose shall be removed or covered as approved by the Engineer. Sign coverings shall be of such material and so placed such that the information contained thereon will not be legible during day or night. The Contractor shall not allow vegetation, construction materials, equipment, etc. to obscure an applicable traffic control device.

No change in posted regulatory speed signs may be made without the written authority of the Department. However, advisory speed plates conforming to the current MUTCD may be used in conjunction with the other standard warning signs provided each posted advisory speed is appropriate for the individual hazard created by construction. All proposed changes in regulatory speeds shall be submitted through the District Engineer and forwarded with any recommendations to the State Traffic Engineer for further handling and consideration by the proper authority.

Unless otherwise provided in the contract, no measurement for payment will be made for materials or work under this subsection, it being understood that the cost thereof is included in the price bid for Maintenance of Traffic or other items of work.

107.11--Use of Explosives. The use of explosives is not permissible under any condition or on any project unless approved in writing by the Engineer. When using explosives, the Contractor shall exercise utmost care not to endanger life and property including the new work. The Contractor shall be responsible for all damage resulting from the use of explosives and shall indemnify and hold harmless the Commission, the Department, and any of its officers or employees.

The Contractor shall comply with all laws and ordinances as well as Title 29 Code of Federal Regulations Part 1926, Safety and Health Regulations for Construction (OSHA), with respect to the use, handling, loading, transportation and storage of explosives and blasting agents.

The Contractor shall notify each property owner and public utility company having structures or facilities in proximity of the explosive work and shall notify all known owners or operators of shortwave radio equipment in the area. Such notice shall be given sufficiently in advance to enable those involved to take steps to protect their property.

107.12--Protection and Restoration of Property and Landscape. The Contractor shall be responsible for the preservation of public and private property and shall protect from disturbance or damage all land monuments, historical markers, and property marks and shall not move them until the Engineer has witnessed or otherwise referenced their location.

The Contractor shall be responsible for all damage or injury to public or private

property of any character resulting from any act, omission, neglect, misconduct, inefficiency, method of executing the work or non-execution thereof or due to defective work or materials and shall indemnify and hold harmless the Commission, the Department, or any of its officers or employees for any such actions or omissions.

The Contractor shall take sufficient precaution to prevent pollution of streams, lakes and reservoirs with any harmful materials including but not limited to fuels, oils, bitumens, calcium chloride, and poisons. The Contractor shall schedule and conduct grading operations, production of materials from material pits or quarry sites exclusive of commercially operated sources, construction of haul roads, hauling operations and other operations so as to prevent or minimize the pollution of adjacent property, ditches, streams, lakes and reservoirs with mineral or organic sediment. Pollution causing injury or damage within the intent of this subsection shall be subject to the restoration requirements and provisions herein set forth.

The Contractor shall restore the property, at no additional costs to the Commission, to a condition equal to that existing before the damage or injury, or shall make good such damage or injury in an acceptable manner.

In case of failure on the part of the Contractor to restore or make good such damage or injury, the Engineer may, upon forty-eight hours written notice, proceed to repair, rebuild or otherwise restore such property and the cost thereof shall be deducted from monies due or which may become due the Contractor. In the event no such monies are available, the amount shall be charged against the Contractor's Surety.

Nothing within this subsection shall be construed to relieve the Contractor from the responsibilities under the requirements of Subsection 107.01.

107.13--Forest Protection. In carrying out work within or adjacent to State or National Forests or other forest areas, the Contractor shall comply with all regulations of the State Fire Marshall, Forestry Commission, Forest Service and all other authority having jurisdiction of the forests and shall observe all sanitary laws and regulations with respect to the performance of work in forest areas. The Contractor shall keep the areas in an orderly condition, dispose of all refuse, 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 Forest Supervisor.

The Contractor shall take all reasonable precaution to prevent and suppress forest fires. The Contractor's employees and subcontractors shall be required to do all reasonably within their power to prevent and suppress forest fires and to notify at the earliest possible moment a Forest Supervisor or other appropriate official of the location and extent of any fire seen by them.

107.14--Damage Claims and Insurance.

107.14.1--Responsibility for Damage Claims. The Contractor shall indemnify and save harmless the Commission, its officers and employees from all suits, actions or claims of any character brought because of injuries or damage received or sustained by person(s) or property resulting from the Contractor's operations; or on account of or in consequence of any neglect in safeguarding the work; or because of any claims or amounts recovered from infringements of patent, trademark, or copyright; or from claims or amounts arising or recovered under the "Workmen's Compensation Act" or any other law, ordinance, order or decree. Money due the Contractor may be retained for the use of the State or Commission or in case no money is due, the Contractor's Surety may be held until such suits, actions or claims for injuries or damages have been settled and suitable evidence to that effect furnished to the Department. Money due the Contractor will not be withheld when satisfactory evidence is produced that the Contractor is adequately protected by public liability and property damage liability insurance.

107.14.2--Liability Insurance.

107.14.2.1--General. The Contractor shall carry public liability and property damage liability insurance of limits not less than: bodily injury --\$100,000 each person, \$200,000 each occurrence; property damage --\$50,000 each occurrence \$250,000 aggregate; automobile liability insurance--\$100,000 each person, \$200,000 each occurrence for bodily injury, and \$50,000 property damage. Each policy shall be signed or countersigned by a Mississippi resident agent of the insurance company.

The Contractor shall have certificates furnished to the Department from the insurance companies providing the required coverage. The certificates shall be on a form acceptable to the Executive Director and show the types and limits of coverage. The Executive Director may request duplicate or certified copies of the policies.

107.14.2.2--Railroad Protective. The following provisions are applicable to all work performed under a contract on, over or under the rights-of-way of each railroad shown on the plans.

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

Prior to starting any work on railroad property, the Contractor shall furnish satisfactory evidence to the Department that insurance of the forms and amounts set out herein in paragraphs (a), (b) and (c) has been obtained. Also, the Contractor shall furnish similar evidence to the Railroad Company that insurance has been obtained in accordance with the Standard Provisions for General

Liability Policies and the Railroad Protective Liability Form as published in the Code of Federal Regulations, 23 CFR 646, Subpart A. Evidence to the Railroad Company shall be in the form of a Certificate of Insurance for coverages required in paragraphs (b) and (c), and the original policy of the Railroad Protective Liability Insurance for coverage required in paragraph (a).

All insurance herein specified shall be carried until the contract is satisfactorily complete as evidenced by a release of maintenance from the Department.

The Railroad Company shall be given at least 30 days notice prior to cancellation of the Railroad Protective Liability Insurance policy.

For work within the limits set out in this subsection, the Contractor shall provide insurance for bodily injury liability, property damage liability and physical damage to property with a combined amount of \$2,000,000 per occurrence and an aggregate of \$6,000,000 applying separately to each annual period for each of (a), (b) and (c) as set out herein. Bodily injury shall mean bodily injury, sickness, or disease, including death at anytime resulting therefrom. Property damage shall mean damages because of physical injury to or destruction of property, including loss of use of any property due to such injury or destruction. Physical damage shall mean direct and accidental loss of or damage to rolling stock and their contents, mechanical construction equipment or motive power equipment.

(a) Railroad Protective Liability Insurance shall be purchased on behalf of the Railroad Company by the Contractor. When applicable, AMTRAK shall be included as an additional insured.

(b) Regular Contractor's Public Liability and Property Damage Insurance, including XCU and automobile, issued in the name of the Contractor shall be so written as to furnish protection to the Contractor respecting the Contractor's operations in performing work covered by the contract. Coverage shall include protection from damages arising out of bodily injury or death and damage or destruction of property which may be suffered by persons other than the Contractor's own employees.

(c) When the Contractor sublets a part of the work to a Subcontractor, the Contractor shall secure insurance protection in their own behalf under Contractor's Protective Public Liability and Property Damage Insurance, including XCU and automobile, to cover any liability imposed on them by law for damages because of bodily injury or death and damage or destruction of property as a result of work undertaken by a Subcontractor.

107.15--Third Party Beneficiary Clause. It is not intended by any of the provisions of the contract to create the public or any member thereof as a third party beneficiary or to authorize any one not a party to this contract to maintain a

suit for personal injury or property damage pursuant to the provisions of this contract. The duties, obligations and responsibilities of the parties to this contract with respect to third parties shall remain as imposed by law.

107.16--Opening Sections of Project To Traffic. If the project is not already open to traffic in accordance with the provisions of Subsection 104.04, at the option of the Executive Director, all or any part may be opened to traffic. The Department will install the traffic control devices necessary for the safety and convenience of traffic. Maintenance of traffic expense will be borne by the Department, or the Contractor will be compensated in accordance with Subsection 109.04 if ordered to provide maintenance of traffic. Opening sections of a project to traffic in accordance with this subsection will be in writing and will not constitute acceptance of the work, or any part thereof, or a waiver of any provision of the contract.

All damage to the highway, including damage or defacement of traffic control devices furnished and erected by the Department, which is the fault of the Contractor shall be repaired or replaced at the expense of the Contractor.

If the Contractor is dilatory in completing shoulders or other features of work, the Executive Director may order all or a portion of the project open to traffic as set out herein; but in such event the Contractor shall not be relieved of liability and responsibility during the period the work is so opened prior to release of maintenance. The remainder of the Contractor's construction operations shall be conducted as to cause the least obstruction to the safe and convenient movement of traffic.

107.17--Contractor's Responsibility for Work. Until release of maintenance in accordance with Subsection 105.16, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage by action of the elements or from any other cause, whether arising from the execution or the nonexecution of the work. The Contractor shall rebuild, repair, restore and make good, in accordance with the requirements of the contract, all injuries or damages to the work occasioned by any of the above causes before release of maintenance and shall bear the expense thereof.

If the Engineer determines the work has been properly prosecuted, constructed, protected and maintained and significant damage to the work is determined to be caused by unforeseeable occurrences beyond control of and without the fault or negligence of the Contractor, including but not restricted to acts of nature, of the public enemy or of governmental authorities, the Contractor will be paid for repairing such damage at the contract unit prices for applicable items involved in making repairs.

When contract items are not applicable to repair of work damaged from such cause, a supplemental agreement may be entered into or such repairs may be

accomplished under the provisions of Subsection 109.04, Extra and Force Account Work.

If the Engineer determines that such repair work has not been properly prosecuted and maintained or determines that the Contractor has not taken all reasonable measures to provide adequate protection for partially completed or completed repair work, payment for repairs will not be made.

Damage to items of construction, caused by the traveling public on a project or section(s) of a project open to traffic, shall be repaired by the Contractor. The Contractor will be paid for repairing such damage to certain acceptably installed items of construction at the contract unit price(s) for the applicable item(s) used in the repair. An acceptably installed item shall be complete-in-place meeting the requirements of the specifications. The acceptably installed items of construction eligible to receive payment for repair of damage caused by the traveling public shall be items used for signing, safety and traffic control. The eligible items shall be limited to traffic signal systems, signs and sign supports, lighting items, guard rail items, delineators, impact attenuators, median barriers, bridge railing or permanent pavement markings. If damage to the above items necessitate only minor repairs, in lieu of total replacement, the work shall be performed in accordance with Subsection 109.04, or as directed by the Engineer. Damage not meeting the requirements to qualify for repair payment shall be repaired at no additional cost to the Commission.

In case of suspension of work from any cause whatsoever, the Contractor shall be responsible for the work and shall take the precautions necessary to prevent damage to the work, provide for normal drainage, erect necessary temporary structures, signs or other facilities; shall maintain the work in such a manner as to fully carry out the responsibility for maintaining traffic as required under the contract; shall properly and continuously maintain in an acceptable growing condition all living material in newly established plantings, seedings, and soddings furnished under the contract, and shall take adequate precautions to protect new tree growth and other vegetative growth against injury. Except when the suspension is ordered by the Engineer for the sole benefit of the Department, all such protection and maintenance shall be preformed by the Contractor without additional cost to the State.

107.18--Contractor's Responsibility for Utility Property and Services. Where the Contractor's operations are adjacent to or coincide with properties of railroad, telegraph, telephone, power companies and other utility services and damage to said utility might result in considerable expense, loss or inconvenience, work shall not commence until all arrangements necessary for the protection thereof have been made.

All work to be performed within 50 feet either side of the centerline of any railroad track shall be executed in such manner and at such time that interference

with the movements of trains or traffic upon the tracks of the Railroad Company is held to a minimum. The Contractor will be required to use all reasonable care and precaution in order to avoid accidents, damage, or unnecessary delays which would interfere with the Railroad Company's trains or other property.

The Contractor shall cooperate with the owners of all underground and overhead utility lines in the removal and rearrangement operations in order that these operations may progress in a reasonable manner and that duplication of rearrangement work may be reduced to a minimum and services rendered will not be unnecessarily interrupted.

In the event of interruption to utility services as a result of accidental breakage or as a result of being exposed or unsupported, the Contractor shall promptly notify the proper authorities and cooperate in the restoration of service. No work shall be undertaken around fire hydrants without approval of the local fire authority.

The Contractor is advised of Section 45-15-1, et seq., Mississippi Code of 1972, regarding the performance of work in the proximity of high voltage overhead power lines. It is the Contractor's responsibility to comply with those statutory requirements.

107.19--Furnishing Rights-of-Way. The Department will be responsible for the securing of all necessary rights-of-way in advance of construction. Exceptions will be indicated in the contract.

107.20--Personal Liability of Public Officials. In carrying out the provisions of the contract or exercising the authority granted by or within the scope of the contract, there shall be no liability upon the Commission, Engineer or authorized representative or any officers or employees of the Commission, either personally or as officials of the State; it being understood that in all such matters they act solely as agents and representatives of the State.

107.21--No Waiver of Legal Rights. The Commission shall not be precluded or estopped by any measurement, estimate or certificate made either before or after the completion and acceptance of the work and payment therefor from showing the true amount and character of the work performed and materials furnished by the Contractor, nor from showing that any such measurement, estimate or certificate is untrue or is incorrectly made, nor that the work or materials do not in fact conform to the contract. The Commission shall not be precluded or estopped, notwithstanding any such measurement, estimate or certificate and payment in accordance therewith, from recovering from the Contractor or the Contractor's Sureties, or both, within the provisions of the laws of the State of Mississippi such damage as may be sustained by reason of failure to comply with terms of the contract. Neither the acceptance by the Commission or the Department or any representative nor any payment for or acceptance of the whole or any part of the work, nor any extension of time, nor any possession taken by

the Department shall operate as a waiver of any portion of the contract or of any power herein reserved or of any right to damages. A waiver of any breach of the contract shall not be held to be a waiver of any other subsequent breach.

The Commission reserves the right to correct an error in any estimate that has been paid and to adjust to meet the requirements of the contract and specifications. Upon conclusive proof of error or collusion or dishonesty between the Contractor or the Contractor's agents and the Engineer or the Engineer's representative being discovered after final payment has been made, the Commission reserves the right to claim and recover by process of law, sums as may be sufficient to correct the error or make good the defects in the work resulting from such errors, dishonesty or collusion.

107.22--Environmental Protection. In addition to the applicable provisions of Subsections 107.01 and 107.12, occupancy by the Contractor of any lands, whether on or off the right-of-way, for the performance of any work under the contract, or preparation therefore, shall be contingent upon provisions being made and carried out for the prevention or minimization of siltation, pollution from soil erosion, and air pollution. Accordingly, it is the intent of the contract that erosion be prevented by the establishment of all necessary temporary and permanent erosion control features as the work progresses from beginning to completion. The primary objective shall be to establish and maintain all permanent erosion control features as soon as possible. Until such time, each operation shall include the effective use of temporary measures as necessary to maintain ground surface conditions so as to prevent or minimize siltation or pollution.

107.22.1--Contractor's Protection Plan. At the preconstruction conference or prior to starting any work on the project, the Contractor shall submit to the Engineer for approval, an erosion control plan to supplement permanent erosion control work required under the contract. As a minimum, the plan shall include the following:

1. Plan profile sheets, 11" x 17" or larger, of the entire project showing the locations of erosion control devices (pay items) such as silt fence, hay bales, silt basins, slope drains, etc. Also, showing the locations of other Contractor absorbed measures such as brush barriers, diversion berms, etc. that the Contractor may elect to use to prevent siltation.
2. A plan for disposal of waste materials, if applicable.
3. A detailed schedule of operations at locations of high siltation potential to clearly indicate how siltation of streams, lakes and reservoirs and the interruption of normal stream flows will be held to a practical and feasible minimum.

The plan shall be updated as needed during the progress of the project. Work shall not be started until an erosion control plan is approved by the Engineer.

The Engineer will have the authority to suspend all work and/or withhold payments for failure of the Contractor to carry out provisions of the erosion control plan and/or proper maintenance thereof.

107.22.2--Clearing and Grubbing, Haul Roads, Waste Areas, Plant Sites or Other Areas Occupied by the Contractor. Clearing and grubbing on erodible areas, construction and maintenance of haul roads, plant sites or other areas occupied by the Contractor in connection with the work shall include adequate protection for preventing excessive erodible material from entering water or waterways on land not occupied by the Contractor and preventing dust created by hauling equipment.

Temporary measures as necessary shall be employed by the Contractor from the beginning of the work. These measures may consist of the expeditious use of brush, vegetation or other residue from clearing and grubbing, temporary or permanent terraces, berms, dikes, dams, sediment basins or other effective means of containing sediment. All temporary or permanent erosion control features shall be maintained in an effective manner so long as essential to the abatement of siltation.

After temporary features are no longer useful or needed, such features shall be removed and the area restored or prepared for subsequent work. All temporary protection shall be the responsibility of the Contractor, and measurement for direct payment will not be made unless otherwise provided in the contract.

Unless otherwise determined by the Engineer from a study of overall job conditions, the exposed surface area of erodible material at any one time for each of the separate operations of this subsection shall not exceed 750,000 square feet without prior approval by the Engineer.

In addition to the applicable requirements of the Mississippi Department of Environmental Quality, Office of Pollution Control, the burning of waste vegetation resulting from site or right-of-way clearing shall meet the following requirements:

- (a) Starter and auxiliary fuels must not cause excessive visible emissions. Rubber tires, etc. are prohibited.
- (b) Must be permitted by local ordinance.
- (c) The burning must be conducted at least 500 yards from an occupied dwelling; this restriction may be reduced to 50 yards if forced draft air is provided for combustion.

- (d) The burning must be conducted at least 500 yards from commercial airport property, private airfields or marked aircraft approach corridors except when a lesser distance is authorized by the airport authority.
- (e) Must not produce a traffic hazard.
- (f) Burning will not be allowed during a High Fire Danger Alert issued by the Mississippi Forestry Commission or an Emergency Air Pollution Episode Alert issued by the Mississippi Department of Environmental Quality, Office of Pollution Control.

107.22.3--Pit Operations. The Contractor shall schedule, arrange and conduct pit operations in such a manner to prevent siltation or pollution of ditches, streams, lakes, reservoirs and adjacent property with sediment, fuels, oils or other objectionable materials.

107.22.4--Structures, Grading, and Other Construction. The Contractor shall perform all work required under the contract in such manner and with such protective features to control and contain siltation within the limits of the work. Performance in the designated or directed sequence and the providing of all erosion protection for which pay items are not included in the contract shall be considered as included in prices bid for other items of work.

The Contractor shall prevent or minimize undesirable siltation in connection with excavation, construction and backfill of structures. Such temporary measures as are indicated herein for clearing and grubbing or other measures such as covering of excavated materials, lining channels, constructing bulkheads or other effective measures shall be employed.

The Engineer will limit the areas of excavation, borrow, and embankment operations commensurate with the Contractor's capability and progress in keeping the finish grading, seeding, mulching, and other such permanent erosion control measures current. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be used to the extent feasible and justified. The exposed surface area of erodible material at any one time for each grading operation shall not exceed 750,000 square feet without prior approval by the Engineer.

The Engineer may increase or decrease the areas of erodible material to be exposed at any one time by clearing and grubbing, excavation, borrow and fill operations as determined by analysis of project conditions.

It is the intent of these specifications that the work shall proceed in a manner and sequence to ensure the earliest possible establishment of permanent erosion control items.

107.22.5--Special Temporary Erosion Control. The plans may designate special temporary erosion control work such as fast growing grasses or other designated temporary features for problem areas during grading, paving or other construction work. Unless otherwise provided, quantities for such temporary features shown on the plans will be included in items for which bids are to be received. The Contractor shall perform all designated temporary work as indicated on the plans or provided in the contract or as directed by the Engineer at the time and in the manner deemed to provide the most effective deterrent to siltation.

Any emergency temporary erosion control will be authorized and used only under conditions or causes created solely by the State or unforeseeable causes beyond the control of the Contractor. The Engineer shall be the sole judge as to the use and payment of emergency temporary erosion control work. Unforeseen special emergency erosion control features not contemplated in the plans or contract documents and determined by the Engineer to be essential for the prevention of siltation and pollution for conditions or causes created solely by the State or unforeseeable causes beyond the control of the Contractor shall be performed as Extra Work.

107.22.6--All Operations. It shall be fully understood that nothing in this subsection shall be construed in any manner to relieve the Contractor from any of the responsibilities for the establishment of permanent roadside development items and other permanent work specified for erosion control in the sequence and manner included in other provisions and requirements of the contract.

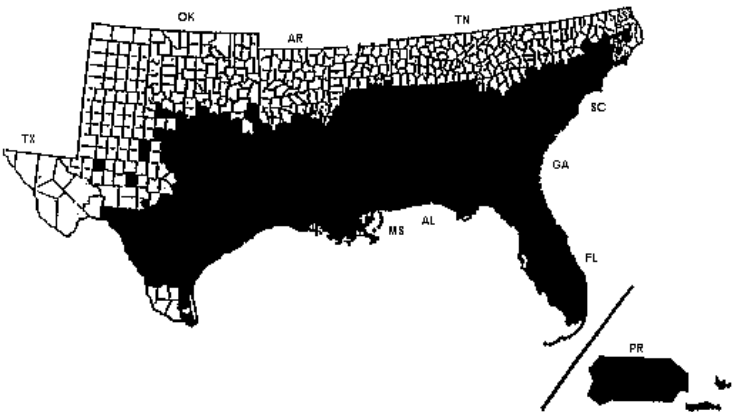
107.22.7--Quarantine Information. At the request of the U. S. Department of Agriculture, plant pest control information concerning domestic quarantines is cited as follows:

The entire state of Mississippi has been quarantined for the Imported Fire Ants. Soil and soil-moving equipment operating in the state will be subject to plant quarantine regulations. In general, these regulations provide for cleaning soil from equipment before it is moved from the state. Complete information may be secured from the State of Mississippi Department of Agriculture and Commerce, Bureau of Plant Industry, P. O. Box 5207, Mississippi State, Mississippi 39762-5207, Telephone 662-325-3390.

IMPORTED FIRE ANT QUARANTINES

The following regulated articles require a certificate or permit for movement:

1. Soil, separately or with other things, except soil samples shipped to approved laboratories*. Potting soil is exempt, if commercially prepared, packaged and shipped in original containers.
 2. Plants with roots with soil attached, except houseplants maintained indoors and not for sale.
 3. Grass sod.
 4. Baled hay and straw that have been stored in contact with the soil.
 5. Used soil-moving equipment.
 6. Any other products, articles, or means of conveyance of any character whatsoever not covered by the above, when it is determined by an inspector that they present a hazard of spread of the imported fire ant and the person in possession thereof has been so notified.
- * Information as to designated laboratories, facilities, gins, oil mills, and processing plants may be obtained from an inspector.



Conditions of Movement.

Counties entirely colored are completely regulated; Counties partially colored are partially regulated.

 Regulated Area.

Restrictions are imposed on the movement of regulated articles as follows:

From colored areas into or through white areas.

Contractors should consult their State or Federal plant protection inspector or County Agent for assistance regarding exact areas under regulation and requirements for moving regulated articles. For detailed information, see 7 CFR 301.81 for quarantine and regulations.

107.23--Material Pits. The Contractor is reminded of the Mississippi Surface Mining and Reclamation Act and the Rules and Regulations adopted to implement this act. Questions or problems concerning the Act or the Rules and Regulations should be directed to the Mississippi Department of Environmental Quality, Office of Geology, Jackson, Mississippi.

Prior to opening a new pit or enlarging an existing pit, the Contractor will furnish the Engineer either a copy of the "Notification of Exempt Operations" or a copy of the (permanent or temporary) Class II Permit approval from the Mississippi Department of Environmental Quality, Office of Geology. The Contractor shall also obtain a letter stating that the pit site is satisfactory from an archaeological and historical standpoint from the Mississippi Department of Archives and History, Historic Preservation Division, Jackson, Mississippi. All costs involved in obtaining clearance shall be borne by the Contractor. Delays encountered in obtaining clearance will not be a reason for extension of contract time. This requirement is not applicable to commercial sources.

When the contract requires the Contractor to dispose of excavated material, the Contractor shall, prior to removal, furnish the Engineer with a copy of a letter from the land owner stating that the Contractor has the right to place material on the said property. The Contractor shall also furnish the Engineer with a letter stating that the property is not in a wetland. Delays encountered in obtaining this information will not be a reason for extension of contract time. This requirement is not applicable to commercial sources.

The Contractor is further reminded of and shall comply with the requirements of the Clean Water Act Amendments requiring National Pollutant Discharge Elimination System (NPDES) permits for discharges composed entirely of storm water from active or inactive surface mining operations, excluding work areas covered by a U. S. Army Corps of Engineers Clean Water Act Section 404 Permit. Questions or problems concerning NPDES permits should be directed to the Mississippi Department of Environmental Quality (MDEQ), Office of Pollution Control, Industrial Branch, Jackson, Mississippi.

The Contractor shall, before a regulated area is opened or enlarged as a material pit, obtain from MDEQ the necessary Mining Storm Water NPDES Permit(s) authorizing the discharge of storm water subject to the terms and conditions of said permit. The Contractor shall furnish the Engineer a copy of the MDEQ NPDES permit. All costs involved in obtaining the permit(s) shall be borne by the Contractor. Delays encountered in obtaining the permit(s) will not be a reason for extension of contract time.

For regulated commercial sources, the owner(s) shall bear the responsibility for meeting the requirements of the NPDES permitting process.

107.24--Construction Noise Abatement. The Contractor shall comply with all state and local sound control and noise level rules, regulations and ordinances which apply to any work performed pursuant to the contract.

Each internal combustion engine, used for any purpose on the work or related to the work, shall be equipped with a muffler of a type recommended by the manufacturer. No internal combustion engine shall be operated on the project without such muffler.

107.25--Hazardous and/or Toxic Waste Procedures. No matter how extensive a field investigation, the possibility exists that hazardous and/or toxic wastes on a site will go undetected until excavation is initiated. If underground storage tanks (USTs), buried containers, hazardous and/or toxic substances are uncovered, or even suspected, during construction, work in this area shall be immediately discontinued and measures taken to protect susceptible nearby wetlands or ground-water sources, and the Engineer shall be immediately notified.

It is essential that the suspected hazardous substances be left in place until they have been identified. The Contractor shall make every effort to prevent the Contractor's personnel, State personnel and the general public from becoming exposed to substances that may be hazardous or toxic. Once contaminated soil or debris has been removed from the ground and leaves the site, it is considered a hazardous waste if the concentration exceeds regulatory levels. In such cases, the Contractor becomes a hazardous waste generator.

Disposition of all underground storage tanks (USTs), containers, hazardous and/or toxic waste shall be in accordance with current rules and regulations of the Department of Environmental Quality, Office of Pollution Control.

The Contractor shall report to the Engineer and the Office of Pollution Control any evidence or conditions which may cause suspicion that a waste site of hazardous or toxic materials and/or containers or USTs has been located within right-of-way limits of the construction project. Work shall cease immediately at such suspected site and shall not resume until directed by the Engineer.

When the Contractor is required to perform additional work to dispose of such waste, containers and/or USTs, payment will be made at contract unit prices which are applicable to the work and/or as provided in Subsection 109.04 when the contract does not include appropriate pay items.

The Department reserves the right to use other forces for exploratory work to identify and determine the extent of hazardous and/or toxic waste. Should the disposition of such material require special procedures by certified personnel, the Department will make arrangements with qualified persons to dispose of the material.

When the existence of USTs are known in advance of construction activity, the Contractor shall give the Office of Pollution Control written notification 30 days in advance of removal.

When an underground storage tank contains or has been used for containment of a regulated substance and the Contractor is required to remove such tank in accordance with the provisions of Subsection 104.05, the Contractor shall not use "flotation" as a method of removal.

SECTION 108 - PROSECUTION AND PROGRESS

108.01--Subletting of Contract.

108.01.1--General. The total value of all work performed by the Contractor's own organization shall be no less than 40 percent of the value of the remaining work after subtracting the contract value of the specialty items from the value of the original contract.

The Contractor's "own organization" shall be construed to include workmen employed and paid directly, owned or rented equipment and trucks that are classed as owner-operator.

All items that have been selected as specialty items will be listed as such in contract documents.

The Contractor shall not sublet any portion of the contract or work provided therein, except the furnishing of necessary materials, without the approval of the Executive Director. Approval to sublet any portion of the contract or work to a Contractor that the Department refuses to issue a proposal, in accordance with Section 102, will not be granted.

Consideration will be given to requests to sublet a portion of the total value of a contract pay item. When the Contractor proposes to sublet a portion of a pay item, the Contractor's request shall be accompanied by a breakdown of the costs

of the various components of each pay item, including haul if applicable, that is proposed to be sublet by part.

Computation of the percentage of the work sublet shall be based on the contract price of each item or in the case of subletting a part of a pay item, the percentage shall be based on the amount acceptably established by the Contractor.

The simple expediency of carrying the workmen of one contractor on the prime Contractor's or approved subcontractor's payroll to avoid subcontracting will not be permitted.

If evidence and investigation establish that a violation of the subcontract requirement is being attempted through subterfuge whereby one contractor's equipment is leased to the prime Contractor, except as provided in Subsection 108.01.2, or the workmen of one contractor are placed on the payroll of the prime Contractor, the Executive Director will take such action as deemed appropriate under the provisions of the contract and may suspend the bidding qualifications of those found to be in violation for a period of up to one year. This provision does not include the lease or use of equipment from a corporation or company wholly owned by the prime Contractor.

Subcontracting does not release the Contractor of bond and contract liability and shall not be construed to imply that a contract exists between the Department and a third party.

The Contractor must pay subcontractor(s) for satisfactory performance of their contracts no later than 15 calendar days from receipt of payment from the Department. Within 15 calendar days after receiving payment from the Department for work satisfactorily performed, the Contractor shall make prompt payment to all sub-contractors or material suppliers for all monies due. Within 15 calendar days after receiving payment from the Department for work satisfactorily completed, the Contractor shall promptly return all retainage monies due to all sub-contractors or material suppliers.

108.01.2--Work Performed by Equipment Rental Agreement. Work may be performed by equipment operated under Department approved rental agreements independent of the provisions of Subsection 108.01.1.

Trucks which may be licensed for operation on the highways of Mississippi are excluded from prior approval of rental agreements under this provision. For other equipment prior approval of a rental agreement shall be obtained in writing before the equipment is used on the work. Consideration for approval will be made by the Resident or Project Engineer, District or Central Office depending on the nature and scope of the proposed rental agreement and the administrative procedures established by the Department.

At least one of the following qualified conditions is a prerequisite for approval of equipment rental:

- (a) Equipment may be rented from a dealer or firm in the business of selling, renting or leasing equipment when the firm or dealer is not a highway contractor or subcontractor. In the event, the dealer or firm is a contractor or subcontractor, consideration for approval will be given under one of the subsequent conditions.
- (b) Equipment may be rented from another contractor provided such contractor does not have a contract with the Department or an approved subcontract; or the Contractor or Subcontractor is maintaining satisfactory progress on all work under contract or subcontract, and the equipment proposed to be rented is not essential to the maintenance of satisfactory progress.
- (c) An occasional piece of equipment may be rented from any party for valid reasons such as breakdown of Contractor owned equipment, temporary need for equipment not normally anticipated for the type of work to be performed or for temporary need for special equipment not normally owned for the type of work involved.

For any work proposed to be performed by rental equipment, the Contractor shall in advance of such use notify the Resident or Project Engineer on the Department's Standard Equipment Rental Request form. The notification shall contain a list and description of equipment, the name of the supplier, the rental rate to be paid, the estimated time use, and the affirmation shown on the form.

In no circumstance shall a Contractor be entitled to any damages for rental or rental rates of equipment where the advanced notification is not given to the Resident or Project Engineer, and the failure to provide the advanced notice shall constitute a waiver of any such claims.

Lease-rental agreements shall provide reimbursement based on time or in the case of trucks: ton, cubic yard, ton-mile, cubic yard-mile, etc. Equipment and operators, if included, shall be under the sole direction of the Contractor in the performance of the work.

If approval has been granted for renting equipment from a contractor that has work under contract or subcontract with the Department and the progress on the other work becomes unsatisfactory, the approval shall become null and void. Continued work with the rented equipment shall not be performed except under qualified approval in writing by the Executive Director.

108.02--Notice to Proceed. The Contractor shall not begin construction on any feature of the work before a Notice to Proceed is issued.

The anticipated dates of the Notice to Proceed (NTP) and the Beginning of Contract Time (BCT) will be specified in the proposal. Work performed between the NTP and BCT will not be chargeable as contract time.

If the Department delays the issuance of the Notice to Proceed, the Beginning of Contract Time will automatically be adjusted equal to the number of calendar days of the delay. When the revised date falls on Sunday or a holiday the following day will be the Beginning of Contract Time. The contract time will be extended automatically as provided in Subsection 108.06, and the Department will furnish the Contractor a revised progress schedule as provided in Subsection 108.03.1.

Upon written request from the Contractor and if circumstances permit, the Notice to Proceed may be issued at an earlier date subject to the conditions stated therein and with no revisions in the progress schedule or contract time dates. The Contractor shall not be entitled to any monetary damages or extension of contract time for any delay claim or claim of inefficiency occurring between the issuance of the Notice To Proceed issued prior to the date stated as the Beginning of Contract Time.

Failure of the Contractor to commence work by the date specified for the beginning of contract time or within a reasonable time thereafter may be cause for annulment of the contract.

108.03--Prosecution and Progress.

108.03.1--Progress Schedule. The Department will furnish the Contractor a progress schedule developed for the determination of contract time which may be used as the contract progress schedule, or the Contractor's own proposed progress schedule may be submitted for approval; see Subsection 105.07 for two contracts within the same area. The schedule will be in the form of a bar graph indicating the controlling phases of work, the bid sheet sequence numbers of all pay items in each phase, and the beginning and ending time for each phase. At least one phase of work will be shown to begin not later than the date for beginning of contract time, and at least one phase of work will be shown to be in progress until all work is scheduled to be completed.

If the Contractor elects to furnish a progress schedule for approval by the Engineer, it should be furnished promptly after award of the contract. The progress schedule shall be on the same form and in the same format as the one furnished by the Department. Blank forms are available from the Department at a nominal cost. In preparing said progress schedule, the Contractor may show more but not less than the number of controlling phases shown on the Department schedule, and the "miscellaneous" phase shall be identical to the one shown on the Department schedule. It is desirable to keep the number of phases to the minimum practicable for satisfactorily controlling the progress of the work

and assessment of contract time by the Engineer.

The Contractor's progress schedule shall reflect a realistic rate of prosecution with all work to be completed within the specified contract time. In preparation of said progress schedule, the Contractor shall take into consideration all controlling factors and specified limitations.

In the event the Contractor has not submitted an approvable progress schedule by the time of the preconstruction conference, the progress schedule prepared by the Department and furnished the Contractor shall be the approved progress schedule under the same conditions as if submitted by the Contractor.

An approved progress schedule shall be in effect until the date on which a revised schedule is approved. The approved progress schedule will be the basis for establishing major construction operations, contract time assessment and for checking the progress of the work.

108.03.2--Preconstruction Conference. Prior to commencement of the work, a preconstruction conference shall be held for the purpose of discussing with the Contractor essential matters pertaining to the prosecution and satisfactory completion of the work. The Department will arrange for utility representatives and other affected parties to be present.

If it is requested by either the Contractor or the Engineer, arrangements will be made for their authorized representatives to inspect the project site with plans in hand and carefully observe pertinent conditions relating to the project, including the status of right-of-way, utilities and any other special features.

At the preconstruction conference, the Contractor's proposed progress schedule may in the discretion of the Engineer be approved, rejected, or revisions may be suggested or ordered. If the schedule is to be revised, the progress schedule furnished by the Department shall be in effect until the revisions have been made and the schedule approved.

108.03.3--Commencement and Execution of Work. The work shall begin as set out in the contract documents or approved progress schedule or as directed and shall be prosecuted at the rate necessary to insure its completion within the contract time. During the progress of the work, the Engineer shall be notified sufficiently in advance of the time the Contractor expects to undertake particular features of construction to permit the required layout and inspection. Should particular phases of the work be discontinued by the Contractor, the Engineer shall be notified at least 24 hours in advance of resuming operations.

All work covered by a supplemental agreement shall not commence until the supplemental agreement has been properly executed by all parties.

108.04--Limitations of Operations.

108.04.1--General. Work requiring the presence or services of Department personnel will not be permitted on Sunday, New Year's Day, Independence Day, Labor Day, Thanksgiving Day and Christmas Day, unless the Engineer determines that an emergency or necessity exists. Work on these days, in lieu of supplemental equipment and labor, solely to complete the project within contract time will not be considered a necessity or emergency.

Drainage and minor structures shall be completed ahead of grading to insure proper setting and curing, thorough compaction of backfill, and improved soil conditions for proper embankment construction.

If the Contractor initiates construction on a greater portion of the work than is necessary for proper prosecution or is carrying on operations to the prejudice of work already started, the Engineer may require the Contractor to finish the work in progress before additional portions are started. Work shall be conducted in the manner and sequence necessary to provide for public convenience and safety as set out in Subsection 107.07.

108.04.2--Night Work. When early completion of a particular phase of construction is for public benefit or in the case of emergencies, the Engineer may permit construction after daylight hours unless specifically prohibited by the contract. If night work is permitted, the Contractor shall provide sufficient illumination to satisfy the requirements of Section 680, and the work performed under these conditions shall comply in every respect with the terms and conditions of the contract.

108.04.3--Temporary Suspension of Work. The Engineer will have the authority to suspend the work wholly or in part for as long as necessary because of unsuitable weather, unusually heavy traffic, conditions unfavorable for the satisfactory prosecution of the work, failure of the Contractor to carry out instructions or to perform all provisions of the contract. If it becomes necessary to stop work for an indefinite period, the Contractor shall store all materials so they will not obstruct or impede the traveling public or become damaged in any way. The Contractor shall take every precaution to prevent damage or deterioration of the work, provide suitable drainage of the roadway and erect temporary structures where necessary. Contract time will not be charged for phases of suspended work except during suspension for failure to carry out instructions of the Engineer. Additional compensation will not be paid because of such suspension, except as provided below. The Contractor shall not suspend work without written authority from the Engineer.

If the performance of all or any portion of the work is suspended or delayed by the Engineer in writing for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) and the

Contractor believes that additional compensation and/or contract time is due as a result of such suspension or delay, the Contractor shall submit to the Engineer in writing a request for adjustment within seven (7) calendar days of receipt of the notice to resume work. The failure of the Contractor to submit the written report within the seven-day period officially constitutes a waiver of any claims for additional time or damages. The request shall set forth the reasons and support for such adjustment.

Upon receipt, the Engineer will evaluate the Contractor's request. If the Engineer agrees that the cost and/or time required for the performance of the contract has increased as a result of such suspension and the 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 notified of the Engineer's determination whether or not an adjustment of the contract is warranted.

No contract adjustment will be allowed unless the Contractor has submitted the request for adjustment within the time prescribed.

No contract adjustment will be allowed under this clause to the extent that performance would have been suspended or delayed by any other cause, or for which an adjustment is provided for or excluded under any other term or condition of this contract.

108.05--Character of Workers, Methods, and Equipment. The Contractor shall employ competent and efficient laborers, mechanics, or artisans. Whenever an employee is deemed to be careless or incompetent, obstructs the progress of the work, is intemperate, uncooperative or disorderly, the Contractor shall, upon written request of the Engineer, discharge or otherwise remove said employee from the work and shall not reemploy such person without the written consent of the Engineer.

The methods used in performing the construction, and all equipment, tools and machinery shall be subject to the approval of the Engineer before and during construction. All equipment, tools and machinery used shall be maintained in a satisfactory working condition.

The measure of the capacity and efficiency of machinery and equipment shall be its actual performance on the work. Should it become apparent that the progress of construction is such that the Contractor will be unable to complete the work with the available equipment within contract time, additional equipment meeting the approval of the Engineer may be required.

Permission to use alternative equipment or methods may be granted when it is of a new or improved type, and its use is deemed by the Engineer to be in

furtherance of the intent of these specifications. Continued use shall be contingent upon the capability to produce work consistently equal to, or better than, that which can be produced with the equipment or method specified.

Nothing in this subsection shall relieve the Contractor of the responsibility for producing work of the quality specified in the contract. Should the Contractor continue to employ or re-employ such unsatisfactory person or persons as herein described, fail to furnish suitable and sufficient machinery, equipment or forces for the proper prosecution of the work, all estimates may be withheld until the Engineer's orders are complied with, or the contract may be declared defaulted as hereinafter provided.

108.06--Determination and Extension of Contract Time.

108.06.1--Based on Time Units.

108.06.1.1--General. Unless otherwise indicated in the contract, contract time will be established on a time unit basis. The span of time allowed for the completion of the physical features of work included in the contract will be indicated in the contract documents as total number of time units allowed and will be known as "Contract Time." The completion date will not be specified but will be determined by the number of time units allowed for completing the work.

The span of time allowed in the contract is based on the quantities used for comparison of bids. If satisfactory fulfillment of the contract requires performance of work in greater quantities than those set forth in the proposal, the time allowed for completion will be increased in time units in the same ratio that the cost of the added work, exclusive of the cost of work altered by Supplemental Agreement for which a time adjustment is made for such altered work in the Supplemental Agreement, bears to the total value of the original contract unless it can be established that the extra work was of such character that it required more time than is indicated by the money value. In such cases, reasonable time will be allowed. Original contract value and/or time shall be understood to include work and/or time added or removed by supplemental agreement.

During the months of December, January and February, Time will only be assessed in the miscellaneous phase, unless otherwise specified in the contract.

Except as required for the miscellaneous phase assessment, time will not be charged for Saturdays, Mississippi legal holidays as defined in the contract, and other Department recognized holidays unless the Contractor performs work. Time charges for Saturdays or the noted holidays will be assessed only to the phases on which the Contractor actually works.

Except as required for the miscellaneous phase assessment, time will not be

charged for Sundays, even though the Contractor is permitted or required to perform work as provided by the contract.

Time will not be charged during any required waiting period for placement of permanent pavement markings as set forth in Subsection 618.03 provided all other work is complete except growth and coverage of vegetative items as provided in Subsection 210.01.

108.06.1.2--Contract Time Assessment. The time required to complete the work has been determined by using time units from one of the columns in the following TABLE OF TIME UNITS. Column A will be used for projects consisting primarily of earthwork; Column B will be used primarily for base and pavement projects; Column C will be used for projects consisting primarily of bridges and structures; and Column D will be used primarily for overlay projects. The column applicable to the contract will be indicated in the contract documents.

TABLE OF TIME UNITS

Month	Column A	Column B	Column C	Column D
January	5	5	6	7
February	5	7	8	9
March	9	9	11	13
April	13	14	14	17
May	17	19	19	19
June	19	20	22	19
July	21	22	23	18
August	21	22	23	18
September	20	20	22	17
October	15	17	17	15
November	10	11	11	12
December	5	4	4	6
Calendar Year	160	170	180	170

Allocation of time units for a fractional part of a month will be computed as a proportion of the listed time units for the applicable month.

Time unit assessment will be based on soil and weather conditions and other specific conditions cited in the contract. The Engineer will determine on each applicable day the extent that each work phase in progress could have been productive, regardless of whether the Contractor worked on that phase.

When the Contractor worked or could have worked eight hours or more on a phase, a maximum of eight hours will be shown as productive hours available for

that phase.

A phase will not be considered for assessment unless at least four consecutive satisfactory hours are available prior to noon. If the Contractor elects to work on such a day, time will only be assessed in the phase(s) in which the Contractor actually works.

The "miscellaneous" phase will not be considered a controlling phase and used in the assessment of time units except when shown as the only phase in progress. Under this condition, time units, monthly time units divided by monthly calendar days, will be assessed in accordance with the applicable column in the TABLE OF TIME UNITS.

Time unit assessment for controlling phases will be based on the Average Value per Time Unit (AVTU) of each phase that should be in progress. Time unit assessment for each phase will begin on the time unit number shown on the approved progress schedule for the beginning of the phase; or if work is commenced on a phase earlier than shown on the progress schedule, time unit assessment will begin on the first day of an estimate period following the previous period in which 15 percent of the value of a phase has been earned except a phase shall not commence in the months of December, January and February.

The AVTU of each controlling phase will continue to be included in the determination of available time units until the physical features of the phase have been satisfactorily completed or until the approved progress schedule indicates an interval of no activity. When the nature of the work requires the phase to be split, time charges in the phase will cease when the work in a portion of the phase has been completed, and will re-start when the items of the work in the next portion of the phase begin. If work has not begun in the next portion of the phase, time charges will begin when the time unit number shown on the approved progress schedule for the beginning of the next portion of the phase has been met or exceeded when rounded to the tenth of a time unit.

When the Engineer determines that a controlling phase has been completed as indicated above and there are no other controlling phase(s) in progress at that time, time units will be assessed based on the AVTU of the next immediately scheduled phase(s).

For each day during the contract time, except Sundays and Saturdays and holidays on which the Contractor does not work, the ratio of the AVTU of each phase scheduled to be in progress to the total AVTU of all the phases scheduled to be in progress will be determined. Each ratio thus determined will be multiplied by the satisfactory hours available for the respective phase.

The product thus determined for each phase will be the proportionate productive

hours for that phase. The proportionate hours for each phase will be added and the sum divided by eight with the quotient rounded to the nearest one-tenth (0.1). This number will be the time unit assessment for that day unless the number before rounding is less than two-tenths (0.2) and the assessment is assigned as zero (0.0) time units.

The Engineer will maintain a daily cumulative assessment of available time units throughout the duration of contract time. When the cumulative time unit assessment is equal to the total number of allowed time units, contract time shall expire.

Each month the Engineer will furnish the Contractor with a report showing the number of available time units assessed during the estimate period and the cumulative time unit assessment to date. The Contractor should review the Engineer's report as to the accuracy of the assessment and confer with the Resident or Project Engineer to rectify any differences. Each should make a record of the differences, if any, and conclusions reached. In the event mutual agreement cannot be reached, the Contractor will be allowed a maximum of 15 calendar days following the ending date of the monthly report in question to file a protest Notice of Claim in accordance with the provisions of Subsection 105.17. Otherwise, the Engineer's assessment shall be final unless mathematical errors of assessment are subsequently found to exist, and any claim of the Contractor as to such matter shall be waived.

The percentage elapsed time will be calculated as a direct ratio of the time units assessed to the total time units provided in the contract, or as modified by supplemental agreement.

The percent of completion of the work will be determined by the ratio of the value of the part of the work accomplished to the total contract amount, or amount as modified by supplemental agreement.

When the progress of the work lags more than 20 percent behind the approved progress schedule or the schedule becomes unrealistic because soil and weather conditions have permitted work on some phases and not on others, the Contractor should immediately submit a revised schedule for approval in order that the Engineer's daily assessment will be based on a more realistic schedule. The beginning date for the revisions on the schedule shall be the beginning date of the next report period after the submission. The revised progress schedule shall be accompanied by a written statement from the Contractor indicating any additional equipment, labor, materials, etc. to be assigned to the work to ensure completion within contract time. The total allowed time units shown on the revised progress schedule shall not exceed the total allowed time units in the original contract. Approval of the revised progress schedule shall in no way be construed as a waiver of the provisions of Subsection 108.07. In the event the Contractor does not submit an approvable revised progress schedule, the progress

schedule in effect will continue to be used for the daily assessment of time units.

108.06.1.3--Extension of Time. If the Contractor finds it impossible, for reasons beyond the Contractor's control, to complete the work within the contract time or as extended in accordance with this subsection, the Contractor may, prior to the expiration of the Contract Time as extended, make a written request to the Engineer for an extension of time, justifying the granting of the request. The Contractor's plea that insufficient time was specified is not a valid reason for extension of time. If the Engineer finds that the work was delayed because of conditions beyond the control and without the fault of the Contractor, the time for completion may be extended in such amount as the conditions justify.

Revision to the contract time will be determined by adding the number of time units representing the calendar days of delay to the number of time units at the time of the extension.

If the completion of the project is extended into a season of the year in which completion of certain items would be prohibited or delayed because of seasonal or temperature limitations, the Engineer may waive the limitations provided the completion of the work will not result in reduced quality. When determined that completion of the items out-of-season will cause a reduction in the quality of the work, the completion of the project will be further extended so the items may be completed under favorable weather conditions. In either case, the Engineer will notify the Contractor in writing.

108.06.1.4--Cessation of Contract Time. When the Engineer by written notice schedules a final inspection, time will be suspended until the final inspection is conducted and for an additional 14 calendar days thereafter. If after the end of the 14-day suspension all necessary items of work have not been completed, time charges will resume. If a project is on liquidated damages at the time a final inspection is scheduled, liquidated damages will be suspended until the final inspection is conducted and for seven (7) calendar days thereafter. If after the end of the 7-day suspension all necessary items of work have not been completed, liquidated damages will resume. When final inspection has been made by the Engineer as prescribed in Subsection 105.16 and all items of work have been completed, the daily time charge will cease.

108.06.2--Based on Calendar Date Completion.

108.06.2.1--General. Contract Time will be established on the basis of a Completion Date, as indicated in the contract. The span of time allowed for the completion of the physical features of work included in the contract will be indicated in the contract documents and will be known as "Contract Time."

For contracts in which a Completion Date is specified, the span of Contract Time shall be determined by the number of Calendar Days allowed in the contract

between the date for the beginning of Contract Time and the Specified Completion Date or revised date for beginning of Contract Time and the revised Specified Completion Date in accordance with the provisions of the contract.

The span of time allowed in the contract as awarded is based on the quantities used for comparison of bids. If satisfactory fulfillment of the contract requires performance of work in greater quantities than those set forth in the proposal, the time allowed for completion shall be increased in Calendar Days in the same ratio that the cost of such added work, exclusive of the cost of work altered by Supplemental Agreement for which a time adjustment is made for such altered work in the Supplemental Agreement, bears to the total value of the original contract unless it can be established that the extra work was of such character that it required more time than is indicated by the money value.

The Contractor shall provide sufficient materials, equipment and labor to guarantee the completion of the project in accordance with the plans and specifications within the Contract Time.

At any given date, the ratio of the accumulated monetary value of that part of the work actually accomplished to the total contract bid amount adjusted to reflect approved increases or decreases shall determine the "percent complete" of the work.

The percentage elapsed time shall be calculated as a direct ratio of the expired Calendar Days to the total Calendar Days provided for in the contract.

No extension of the Specified Completion Date will be granted except as provided herein, and, except for abnormal delays caused solely by the State or other governmental authorities, or unforeseeable disastrous phenomena of nature of the magnitude of earthquakes, hurricanes, tornadoes, or flooded essential work areas which are deemed to unavoidably prevent prosecuting the work.

Any revision of the Specified Completion Date provided for in the contract will be made automatically on the Specified Completion Date as established in the contract, and at a later date if additional conditions so warrant.

In the event the Engineer determines that the completion date when extended as provided in the contract would cause certain items of work or portions thereof, properly prosecuted in the normal sequence and manner, to fall within a period of seasonal or temperature limitations, the Engineer will make a determination as to the scope of unavoidable delays, if any, contemplated because of such seasonal or temperature limitations for periods in excess of those contemplated in the original contract. The Executive Director may thereupon establish a revised contract completion date by notifying the Contractor and the Contractor's Surety in writing of such established completion date as warranted by the engineering determination.

Liquidated Damages as set forth under the heading "Per Calendar Day" in the "Schedule of Deductions for Each Day of Overrun in Contract Time," Subsection 108.07, shall be applicable to each Calendar Day after the Specified Completion Date, or authorized extension thereof, and until all work under the contract is completed.

Progress Schedule referred to in Subsection 108.03 will not be required.

108.07--Failure to Complete the Work on Time. When the Contractor fails to complete the work within the time stipulated or as extended under the provisions of the contract, a deduction calculated from the daily charges listed in the schedule will be made from money due the Contractor not as a penalty but as liquidated damages. The daily charges set out in the schedule of liquidated damages are based on an approximate average cost to the Department for maintaining engineers, inspectors and other employees. The Contractor and the Contractor's Sureties shall be liable for all liquidated damages in excess of money due the Contractor.

Schedule of Deductions for Each Day of Overrun in Contract Time

Original Contract Amount		Daily Charge
From More Than	To and Including	Per Calendar Day
\$ 0	100,000	\$ 140
100,000	500,000	200
500,000	1,000,000	300
1,000,000	2,000,000	400
2,000,000	5,000,000	650
5,000,000	10,000,000	750
10,000,000	-----	1,400

The applicable daily charge will be made for each calendar day after the expiration of contract time. Daily charges will not be made during any required waiting period for placement of permanent pavement markings as set forth in Subsection 618.03 provided all other work is complete and during specified growth and coverage of the vegetative items as provided in Subsection 210.01.

108.08--Default and Termination of Contract. The contract may be terminated by the Executive Director for any of the following reasons:

- (a) Failure to proceed with the work when so instructed by the Department or to adhere to the requirements of the contract.
- (b) Failure to perform the work with sufficient workmen, equipment and materials to assure completion within contract time.
- (c) Performing unacceptable work, or neglecting or refusing to remove

materials or to perform anew such work as may be rejected as unacceptable.

- (d) Discontinuing the prosecution of the work.
- (e) Violation of labor provisions and special regulations.
- (f) Becoming insolvent, being declared bankrupt or committing any act of bankruptcy or insolvency.
- (g) Allowing a final judgment to stand unsatisfied.
- (h) Making an assignment for the benefit of creditors.
- (i) Failure for any other cause whatsoever to carry on the work in an acceptable manner.

Before the contract is terminated, the Contractor and Surety will be notified in writing by the Executive Director of the conditions which make termination of the contract imminent. If, for any reason, written notice cannot be delivered to the Contractor, notice of termination may be given by publication in a newspaper in the county in which the project is located. When there is no such newspaper, the notice may be given by publication in a newspaper located in Hinds County. If no effective effort has been made by the Contractor or Surety to correct the conditions of which complaint is made within 15 calendar days after notice is given, the Executive Director may declare the contract terminated and notify the Contractor and Surety accordingly.

Upon receipt of notice from the Executive Director that the contract has been terminated, the Contractor shall immediately discontinue all operations.

After termination, the Executive Director will order the Surety to arrange for the prosecution of the work. If the Surety does not proceed with the satisfactory prosecution of the work within 20 calendar days from the date on which the contract was terminated, the Executive Director may proceed by either readvertising and awarding the contract, or proceed in any other lawful manner which will provide for the completion of the work as planned and set forth in the contract. The Surety or the Department, at the Surety's expense, will perform or arrange for necessary maintenance between the date of termination and the date that work is resumed.

When the work is finally completed, the total cost to the Department will be computed. If the total cost is greater than the cost which would have resulted at the original contract unit prices, the extra expense will be the responsibility of the original Contractor's Surety. If the total cost is less than the cost which would have resulted at the original contract unit prices, the savings will be paid to the

original Contractor's Surety.

108.09--Termination of Contract for Reasons Other Than Default. The Department may, by written order, terminate the contract or any portion thereof after determining that for reasons beyond either Department or Contractor control the work as originally contracted cannot be completed and termination would therefore be in the public interest. Such reasons for termination may include, but need not be necessarily limited to, executive orders of the President relating to war or national defense, national or area emergencies which create a serious shortage of materials, orders from duly constituted authorities relating to energy conservation, and restraining orders or injunctions obtained by third-party citizen action resulting from environmental protection laws or where the issuance of such order or injunction is primarily caused by acts or omissions of persons or agencies other than the Contractor.

For contract purposes "Area Emergency" shall be understood to be an emergency created by an acute shortage of materials, supplies, labor, or equipment within an area in which the project is located and termed usually as the "Trade Area." Specifically for the purpose of this provision, the "Area" under consideration shall be understood to be the area from which the Executive Director determines the Contractor would reasonably obtain materials, supplies, labor, or equipment, respectively.

When the Department orders termination of a contract effective on a certain date under this subsection, all completed items of work as of that date will be paid for at the contract unit price. Payment for partially completed work will be made either at agreed prices or by force account as provided in Subsection 109.04.

Acceptable materials which have not been incorporated in the work, may, at the option of the Department, be purchased at actual cost delivered to a prescribed location, or otherwise disposed of as mutually agreed.

After receipt of Notice of Termination under this subsection from the Department, the Contractor shall, within 60 days of the effective termination date, submit a claim for additional damages or costs not covered herein or elsewhere in these specifications. Such claim may include such cost items as reasonable idle equipment time, mobilization efforts, bidding and project investigative costs, overhead expenses attributable to the project, legal and accounting charges involved in claim preparation, subcontractor costs not otherwise paid for, actual idle labor cost if work is stopped in advance of termination date, guaranteed payments for private land usage as part of original contract, and any other cost or damage item for which the Contractor feels reimbursement should be made. The intent of negotiating this claim would be that an equitable settlement be made with the Contractor. Loss of anticipated profits will not be considered as part of a settlement.

The Contractor's cost records shall be made available to the extent necessary to determine the validity and amount of each item claimed.

Termination of a contract or portion thereof will not relieve the Contractor or Surety of contractual responsibilities for the work completed.

108.10--Termination of Contractor's Responsibility. The contract will be considered complete when all work has been satisfactorily completed, the final inspection made, the work accepted by the Executive Director, and the final estimate paid. When the Executive Director writes the formal letter of acceptance, the Contractor will be released from further obligation except as set forth in the contract bond or as provided by law.

SECTION 109 - MEASUREMENT AND PAYMENT

109.01--Measurement of Quantities. The measurement and determination of quantities for each pay item will be made in general as prescribed hereinafter, and specifically as set out under Method of Measurement and Basis of Payment for each respective pay item. Actual authorized quantities of work, complete and accepted under the contract, will be measured by the Engineer according to United States standard measures, and in accordance with well recognized engineering practices. Unauthorized wastage of material will be deducted and only quantities actually incorporated in the completed work or ordered to be wasted will be included in the final estimate.

A station when used as a definition or term of measurement will be 100 linear feet.

Unless otherwise specified, longitudinal measurements for area computations will be made horizontally, and no deductions will be made for individual fixtures having an area of nine square feet or less. Unless otherwise specified, transverse measurements for area computations will be the neat dimensions shown on the plans or ordered by the Engineer.

Where the area unit for measurement and payment is specified for erosion control items, the measurements will be taken on the slope of the ground to compute the actual surface area for payment.

Structures will be measured according to neat lines shown on the plans or as altered to fit field conditions.

All items which are measured by the linear foot, such as pipe culverts, guardrail, underdrains, etc., will be measured as specified under the Method of Measurement for the item unless otherwise shown on the plans.

No payment will be made for unauthorized excavation. Excavation or embankment performed beyond the required neat lines or slope stakes will not be measured for payment unless within tolerances specified or otherwise provided.

In computing volumes of excavation and embankment, the average end area method will be used, unless otherwise specified.

The thickness of plates and galvanized sheets used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing will be specified and measured in decimal fractions of inches as shown in AASHTO Designation: M 36 or M 167.

When size number is used in the measurement of wire, it will mean the size number specified in AASHTO Designation: M 32.

The term ton will mean the short ton consisting of 2000 pounds avoirdupois. All materials which are specified for measurement by the ton shall be weighed by competent personnel on approved scales set at locations approved by the Engineer or in the case of prepackaged materials, the manufacturer's bag weight may be used. If material is shipped by rail, the car weight may be accepted provided it is the actual weight of material and not minimum car weight used for assessing freight tariff. However, car weights will not be acceptable for material to be used in mixing plants. Trucks used to haul material being paid for by weight shall be weighed empty daily at such time as the Engineer directs, and each truck shall bear a plainly legible identification mark.

Timber, except timber piling, will be measured by the thousand feet board measure (MBM) actually incorporated in the structure. Measurement will be based on nominal widths and thicknesses and the length of each piece.

When a complete structure or structural unit, in effect "lump sum" work, is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

Volumes of materials computed in cubic yards by the average end area method are designated as "Final Measure" (FM), or "Final Measure - Embankment" (FME). Volumes of materials designated for measurement loose in the vehicle are designated as "Loose Vehicle Measure" (LVM).

Volumetric measurement of excavation, embankment, granular materials or similar materials in cubic yards will be made by the methods designated on the plans or in the proposal. For justifiable reasons, such as impracticability of measurement of volumes (usually small) by the designated method, the Engineer may order measurement by another method as follows:

- (a) Volumes designated for payment by FM may be measured LVM and

converted to contract measurement by multiplying the loose measure by 80 percent.

- (b) Volumes designated for payment by LVM may be measured in its original position by the average end area method and multiply the FM measure by 125 percent.
- (c) Volumes designated for payment by FME may be measured in its original position by the average end area method and multiply the FM measure by 90 percent.
- (d) Small volumes of surplus, excess excavation or other small volumes of excavation which are impractical to measure by the average end area method but are designated to be measured by FME may be measured LVM and multiply the loose measure by 72 percent.

When the Engineer orders the use of a conversion factor for converting a unit of measure, the ordered method of measurement shall be deemed acceptable to all parties and shall be final.

When the average end area method is indicated, other three-dimensional measurements of the prismoid occupied by the material in its natural position before removal or in its final position in the embankment may be used.

When requested by the Contractor and with written approval of the Engineer, material specified to be measured by the cubic yard or ton may be converted to the other measure as appropriate. Factors for this conversion will be determined by the Engineer and agreed to by the Contractor before such method of measurement is used.

All materials measured by the cubic yard LVM shall be hauled in approved vehicles and verified at the point of delivery. Vehicles may be of any size or type acceptable to the Engineer provided the body is of such shape that the capacity may be readily and accurately determined to the whole cubic yard in accordance with Department SOP. Unless all vehicles on the work are of uniform capacity, each vehicle must be plainly labeled to indicate its measured capacity. All vehicles shall be legibly numbered for identification.

The vehicles shall be loaded to ensure a water level load when they arrive at the point of delivery. Loads hauled in unapproved vehicles and loads of a quantity less than the measured quantity for the hauling vehicle, will be subject to rejection.

Bituminous materials will be measured by the gallon or ton. Volumes will be measured at 60°F or corrected to the volume at 60°F using tables in Department SOP.

109.02--Scope of Payment. The compensation, as herein provided, constitutes full payment for the complete work including all materials, labor, tools, equipment and incidentals necessary for performing the work contemplated and embraced under the contract; for all loss or damage arising out of the nature of the work; for all loss from the action of the elements, except as otherwise provided; for any unforeseen difficulties or obstruction of the work which may arise or be encountered during the prosecution of the work until its final acceptance by the Engineer; for all risks connected with the prosecution of the work; for all expenses incurred by or in consequence of suspension or discontinuance of the work; for any infringement of patents, trademarks or copyrights; and for completing the work in an acceptable manner according to the plans and specifications.

If the "Basis of Payment" clause for a specific pay item requires that the contract unit price 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 which may appear elsewhere in the specifications.

The payment of any current estimate, prior to final acceptance of the work by the Executive Director, shall in no way constitute an acknowledgment of the acceptance of the work, nor in any way affect the obligation of the Contractor to repair or renew defective parts of the work. The Engineer will be the judge of defects or imperfections, and the Contractor shall be liable to the Department for failure to correct same as provided herein.

109.03--Compensation for Altered Quantities. Whenever the quantity of a pay item is increased or decreased from the original contract quantity, payment will be made on the basis of the actual quantity completed at the contract unit price or as modified by supplemental agreement.

109.04--Extra and Force Account Work. Extra work performed in accordance with the requirements and provisions of Subsection 104.03 will be paid for at the unit prices or lump sum stipulated in the agreement authorizing the work, or the Executive Director may require the Contractor to do such work on a force account basis to be compensated in the following manner:

- (a) **Labor.** The Contractor will receive the rate of wage or scale agreed upon in writing for each hour that the foreman in direct charge of the specific operations and labor are actually engaged in such work. An amount will be added equal to 15 percent of the sum thereof.
- (b) **Bond, Insurance and Tax.** For property damage, liability, and workmen's compensation insurance premiums, unemployment insurance contributions and social security taxes on the force account work, the Contractor will be reimbursed actual cost only. The Contractor shall furnish satisfactory evidence of the rate or rates paid for the bond,

insurance and tax.

- (c) **Materials.** The Contractor will receive the actual cost of the materials, including transportation charges if paid by the Contractor, exclusive of machinery rentals as hereinafter set forth, plus 15 percent.
- (d) **Equipment.** For any machinery or special equipment, other than small tools, authorized by the Engineer, the Contractor will receive the rates agreed upon in writing.

In the event an agreement cannot be reached for a particular piece of equipment, the pamphlet entitled "Construction Equipment Ownership and Operating Expense Schedule, Region III" as published by the Department of Army, U S Army Corps of Engineers and is current at the time the force account work is authorized will be used to determine equipment ownership and operating expense rates. These rates do not include allowances for operating labor, mobilization or demobilization costs, overhead or profit, and do not represent rental charges for those in the business of renting equipment. Operating labor and overhead cost will be allowed. Subject to advance approval of the Engineer, actual transportation cost for a distance of not more than 200 miles will be reimbursed for equipment not already on the project. The cost of transportation after completion of the force account work will be reimbursed except it cannot exceed the allowance for moving the equipment to the work.

The hourly use rates are computed on the basis of a 40-hour work week. When the Contractor works more than 40 hours per week, the cost for "Cost of Facilities Capital" (CFC) will be excluded from the hourly rate for those hours in excess of 40 hours per week.

No more than eight hours of standby will be paid during a 24-hour day, nor more than 40 hours per week. Standby time will not be allowed unless the equipment has been in idle status in excess of 16 hours during a 24-hour day. Likewise, standby will not be allowed during periods when the equipment would have otherwise been in idle status or when equipment could reasonably have been used on other parts of the project. Actual operating time during a week will be credited against the 40 hours maximum standby allowance.

All equipment shall be subject to approval from day to day in accordance with the requirements of Subsection 108.05.

- (e) **Miscellaneous.** No allowance will be made for general superintendence, the use of small tools, or other costs for which no specific allowance is herein provided.

- (f) **Compensation.** No extra work on a force account basis will be paid unless unit prices for labor, materials and equipment rentals have been agreed upon in writing, or as otherwise provided for equipment in paragraph (d), before work is started. The unit prices paid shall not exceed the quoted unit price for each item stipulated in the agreement.

The Contractor, or the Contractor's authorized representative, and the Engineer shall compare records of extra work done on a force account basis at the end of each day. Copies of these records shall be made upon the form provided for this purpose and shall be certified to by the Contractor and the Engineer. The Contractor shall furnish to the Engineer itemized statements of the cost of all force account work. The statements shall include a true copy of the payroll and the original receipt of bills and invoices for the material used and the freight charges paid on same. Where materials used are not specifically purchased for use on extra work but taken from the Contractor's stock, the Contractor may submit an affidavit of the quantity, price and freight on these materials. Statements covering force account work for each specific agreement shall be submitted promptly at the end of the month in which the work was actually completed. Failure to timely submit such information shall constitute a waiver if any claim for monetary damage.

109.05--Eliminated Items. Any item found unnecessary for the proper completion of the work may, upon written order of the Engineer, be eliminated and in no way invalidate the contract. When the Contractor is notified of the elimination of an item, the Contractor will be reimbursed for the actual work and all costs including mobilization of materials prior to the notification as provided in Subsection 104.02.

109.06--Partial Payments.

109.06.1--General. Monthly estimates will be authorized by the Engineer provided the amount due on completed work is no less than \$1,000.00 including advancement on materials. The estimate will be prepared by the Engineer on the day of the month prescribed by the Commission. Partial payment based on estimated quantities and computed at contract unit price will be made on or about the day prescribed by the Commission.

If defective work and/or materials are discovered or reasonable doubt arises as to the integrity of any part of the work for which partial payment has been allowed, a deduction from subsequent estimates in an amount equal to the value of the defective or questioned work will be made until the defects have been remedied or the causes for doubt removed.

Each month the Contractor receives a monthly progress estimate, the Contractor shall review the Engineer's progress estimate as to the accuracy of the quantities. Should the Engineer's estimated quantity for any pay item be greater than a

tolerance of plus or minus ten percent ($\pm 10\%$) of the Contractor's estimated quantity, the Contractor shall confer with the Resident or Project Engineer to rectify any differences. Each should make a record of the differences, if any, and conclusions reached. In the event mutual agreement cannot be reached, the Contractor will be allowed a maximum of 15 calendar days following the ending date of the monthly estimate in question to file in writing, a protest Notice of Claim in accordance with the provisions Subsection 105.17. Otherwise, the Engineer's estimated quantities shall be considered acceptable pending any changes made during the checking of final quantities and any claim by the Contractor shall be considered to have been waived.

109.06.2--Advancement on Materials. Partial payments may include advance payment for certain nonperishable or durable materials with approval of the Engineer. Advance payment may be requested for structural steel members provided fabrication has been completed and the members have been declared satisfactory for storage by a Department representative. The Contractor must make a written request for payment and furnish written consent of the Surety. To qualify for advance payment, materials must be stored or stockpiled on or near the project or at other locations approved by the Engineer; or in the case of precast concrete members, treated timber, guard posts and other approved preprocessed durable and bulky materials, the materials may be stored at the commercial producer's yard provided it is located in Mississippi; or in the case of prestressed concrete members that may require being produced at an out-of-state location, the prestress members shall be produced and may be stored at the commercial manufacturer's yard provided it is a PCI certified plant on the Department's List of Approved Prestress & Precast Plants and it is located within the continental United States; or in the case of structural steel members that may require fabrication at an out-of-state location, the fabricated members may be stored at the location of the commercial fabricator's yard provided it is located within the continental United States. When allowed, advance payment will be based on verified actual material cost plus transportation charges to the point of storage. Sales tax, local haul and handling costs shall not be included as material cost.

Advancements will not be allowed until the Project Engineer has received triplicate copies of material invoices and certified test reports or acceptable certificates of conformance, and in the case of materials stored at the commercial producer's/fabricator's yard, the material shall be positively identified for the specific project and a Certificate of Storage issued by the State Materials Engineer, another designated Department employee or a designated representative of the Department. Requests for advancements on fabricated structural steel members and prestress concrete members stored out-of-state will be denied when the Department does not have available a designated representative to issue a Certificate of Storage.

The Contractor shall make suitable arrangements to the satisfaction of the

Engineer for storage and protection at approved sites or, in the case of materials stored at the commercial producer's yard located in Mississippi or, in the case of fabricated structural steel members stored at the commercial fabricator's yard or prestress concrete members stored at a commercial manufacturer's yard located within the continental United States, the Contractor shall make arrangements with the producer/fabricator for suitable storage and protection. If advanced payment is allowed and the materials are damaged, lost, destroyed or for any reason become unacceptable, the previous payments will be deducted from subsequent estimates until the materials are replaced or restored to an acceptable condition. In all cases, the Contractor shall save harmless the Commission in the event of loss or damage, regardless of cause.

Advanced payment will not be made on living or perishable plant materials or seeds until planted.

Unless specifically provided for in the contract, advance payment will not be made on materials, except for fabricated structural steel members or prestress concrete members, stored or stockpiled outside of the State of Mississippi.

Materials for which an advanced payment has been allowed must be paid for by the Contractor within 60 days of the estimate on which the advanced payment was first allowed and proof of said payment must be verified by the supplier. If proof of payment is not furnished within the allowable 60 days, the advanced payment will be deducted on subsequent current estimates until such time proof of payment is furnished.

As the materials are incorporated into the work, proportionate reductions for advance payments shall be made from monthly estimates covering the work performed. Calculation of percentage of completion, or rate of progress, shall be based on completed work and no consideration will be given to stockpiled materials.

109.06.3--Retainage. Regardless of the value of the earned work based on the value of work scheduled for completion by the approved progress schedule, no deduction for retainage will be made from payments and advancement of materials due to the Contractor. Likewise, the Contractor shall not withhold any retainage from any payments due to a Subcontractor or Supplier.

109.06.4--Withholding of Estimates. An estimate may be withheld indefinitely until all directives of the Engineer, given in compliance with and by virtue of the terms of the contract, have been complied with by the Contractor.

109.07--Changes in Material Costs. Because of the uncertainty in estimating the costs of petroleum products that will be required during the life of a contract, an adjustment in compensation for certain materials may be allowed when provisions are included in the contract. When the pay item on the bid sheets

indicated that an adjustment is allowed, an adjustment will be provided as follows:

Bituminous Products -- Each month the Department will acquire unit prices from producers or suppliers who supply the State highway construction industry with bituminous products. The average of all quotes for each product will serve as the base price for contracts let in the subsequent month.

Fuels -- Selected cash price quotations for bulk gasoline and diesel fuel will be taken from Platt's Oilgram PAD 2 and PAD 3. The appropriate adjustment per gallon for gasoline and diesel fuel will be added to the quotations to allow for taxes and markups. The prices thus determined will serve as the base prices for contracts let in the subsequent month.

The established base prices for bituminous products and fuels will be included in the contract documents under a Notice to Bidders entitled "Petroleum Products Base Prices For Contracts Let In (Month and Year)."

Each month thereafter the Engineer will be furnished with the current monthly prices. Adjustments for change in cost will be determined from the difference in the contract base prices and the prices for the period that the work is performed and for the quantities completed. Adjustments may increase or decrease compensation depending on the difference between the base prices and prices for the estimate period.

The adjustments will be determined for the quantities of bituminous products and the average fuel requirements for processing a unit of work as set forth herein.

COST ADJUSTMENT FACTORS FOR FUEL USAGE

<u>Item of Work</u>	<u>Units</u>	<u>Code</u>	<u>Diesel</u>	<u>Gasoline</u>
Excavation & Embankment, Except Structure and Foundation	gallons/cubic yard	(E)	0.29	0.15
Granular Materials, Stabilizer Aggregates or Coarse & Seal Aggregates	gallons/cubic yard or gallons/ton	(GY) (GT)	0.88 0.62	0.57 0.40
Subgrade & Base Mixing Items	gallons/square yard	(M)	0.044	0.028
Hot Mix Asphalt (HMA)	gallons/ton	(B)	2.57	0.78
Asphalt Drainage Course	gallons/square yard	(D)	0.49	0.15

Portland Cement Concrete Base & Pavement	gallons/square yard	(C)	0.11	0.15
Bridge Items, Structural Concrete, Pipe Culverts, Including Foundation & Structural Excavation and all other Concrete related items	gallons/\$1000	(S)	11.0	13.0

CONSTRUCTION MATERIALS

The items and quantities subject to compensation adjustment:

ADJUSTMENT CODE

- (A1) Asphalt for HMA mixture -- theoretical gallons based on job mix formula, unit weight of 8.43 pounds per gallon, and new asphalt only for recycled HMA mixture.
- (A2) Asphalt for Surface Treatment -- pay quantity in gallons.
- (A3) Asphalt for Prime -- pay quantity in gallons.
- (A4) Asphalt for Curing Seal -- 0.25 gallons per square yard.
- (A5) Asphalt for Bituminous Treated Roving -- 0.50 gallons per square yard.
- (A6) Asphalt for Asphalt Drainage Course -- theoretical gallons per square yard based on job mix formula and unit weight of 8.43 pounds per gallon.

Any difference between checked final quantity and the sum of quantities shown on the monthly estimates for any item will be adjusted by the following formula:

$$FA = (FCQ - PRQ) \times EA$$

Where: FA = Final Adjustment
FCQ = Final Checked Quantity
PRQ = Total Quantity Previously Reported on Monthly Estimate
EA = Total Adjustment Shown on Monthly Estimate

The final adjustment is to consider any error(s) that may have been made in the computations of monthly adjustments.

After the expiration of contract time, including all authorized extensions, adjustments will be computed using fuel and material prices that are in effect at

the expiration of contract time.

109.08--Contract Overpayment(s). The Contractor is duly responsible to and will immediately reimburse the Mississippi Transportation Commission, without any demand therefore, for any overpayment(s) of which it has knowledge, or through due diligence, should have knowledge.

By the execution of the contract, the Contractor also agrees that if the Mississippi Transportation Commission has made any overpayment(s) to the Contractor on any previously executed contract(s), the Mississippi Transportation Commission may notify the Contractor in writing of the nature and the amount of the overpayment(s). If the Contractor fails to remit the overpayment(s) to the Mississippi Transportation Commission within sixty (60) calendar days from the date of such notice, interest shall accrue from the date of such notification until payment is made in full at the rate of one percent (1%) per month until fully paid.

By the execution of the contract, the Contractor also agrees that the Mississippi Transportation Commission may offset and withhold a sum equal to any overpayment(s) on any previously executed contract(s), plus interest, where applicable, against any sums due the Contractor under the terms of this contract or any other active contract(s).

By the execution of the contract, the Contractor also agrees that if any overpayment(s) are made by the Mississippi Transportation Commission to the Contractor under the terms of this contract the Mississippi Transportation Commission shall have the right to offset and withhold that amount, plus interest, where applicable, from any sums which the Mississippi Transportation Commission might owe the Contractor on any other active contract(s) or any future executed contract(s).

109.09--Freight Rates and Labor Rates. No allowance or deduction will be made for increases or decreases in freight rates or demurrage or for any increase or decrease in labor rates unless so stipulated in the contract.

109.10--Blank.

109.11--Acceptance and Final Payment. When the work has been accepted by the Executive Director, a final estimate showing the value of the work will be prepared by the Engineer as soon as the necessary final measurements and computations can be made. The amount of this estimate, less all previous payments and deductions required under the contract, will be paid to the Contractor as soon as practicable. Final payment will not be made until written consent of the Contractor and the Surety has been delivered to the Contract Administration Engineer of the Department. It shall be the Contractor's responsibility to have the Surety provide the consent. Delays in final payment because of non-receipt of Surety's consent shall not be cause for the payment of

interest under the provisions of Section 31-5-27 of the Mississippi Code, 1972, Annotated, for the period of time occasioned by such delay.

Acceptance by the Contractor of final payment shall operate as and shall be a release to the Commission from all claims or liability under the contract and any act or neglect of the Commission relating to or connected with the contract.

109.12--Right to Audit. The Department reserves the right to audit the Contractor's records at any time during the contract period and up to three years after the final contract payment or up to three years after any litigation is filed with court, whichever is later. If the Department commences an audit, the Contractor will be required to provide sufficient original documents and records to satisfy the Department's Audit Division or other appropriate individual that the costs included in the Contractor's claim were incurred and are appropriate for payment under the terms of the contract and solely in performance of the referenced project and project phase and were not incurred on any other project or phase of the referenced project that the Contractor is constructing or has constructed. Department's audit will be conducted in accordance with United States General Accounting Office's Governmental Auditing Standards, the Institute of Internal Auditor's Professional Practice Standards, and the American Institute of Certified Public Accountant's Auditing Standards.

SECTION 110 - REQUIRED CONTRACT PROVISIONS

110.01--Application. Projects constructed without Federal funds.

110.01.1--Statements and Payrolls. The submission by the Contractor of weekly payrolls, or copies thereof, is not required. However, each Contractor and Subcontractor shall preserve weekly payroll records for a period of three years from the date of contract completion. All contractor personnel working at the project site will be paid unconditionally and not less often than once a week without subsequent deduction or rebate on any account, except such payroll deductions as are permitted by regulations, the full amounts of wages and bona fide fringe benefits due at time of payment.

The payroll records shall contain the name, address, social security number, classification, rate of pay, daily and weekly number of hours worked, itemized deductions and actual wages paid to each employee.

Upon request, the Contractor will make payroll records available at the project site for inspection by the Department Contract Compliance Officer or authorized representative and will permit such officer or representative to interview employees on the job during working hours.

The Contractor and Subcontractors shall submit Form CAD-880, "Weekly

Summary of Wage Rates", each week to the Project Engineer. The forms may be obtained from the Contract Compliance Officer, Contract Administration Division, Mississippi Department of Transportation, Jackson, Mississippi. Custom forms, approved by Contract Administration Division, may be used in lieu of CAD forms.

110.02--Application. Projects constructed with Federal funds.

110.02.1--Statements and Payrolls. The Contractor and Subcontractors shall submit weekly two copies of all payrolls to the Project Engineer and meet the requirements of U. S. Department of Transportation Form FHWA 1273, on projects constructed in whole or in part with Federal funds.

The Contractor and sub-contractors shall submit two copies each of Form CAD-880, "Weekly Summary of Wage Rates", and CAD-881, "Weekly Statement of Compliance", each week to the Project Engineer. The forms may be obtained from the Contract Compliance Officer, Contract Administration Division, Mississippi Department of Transportation, Jackson, Mississippi. Custom forms, approved by Contract Administration Division, may be used in lieu of CAD forms.

110.02.2--Wage Rates. All persons employed or working upon the site of the work will be paid at wage rates not less than those contained in the wage determination decision of the Secretary of Labor in effect at time of advertisement for bids and/or contained in the contract.

110.02.3--Classification. The Department Contract Compliance Officer shall require that any class of laborers or mechanics, including apprentices and trainees, which is not listed in the wage determination and which is to be employed under the contract, shall be classified or reclassified conformably to the wage determination.

DIVISION 200 - EARTHWORK AND ROADSIDE DEVELOPMENT**SECTION 201 - CLEARING AND GRUBBING**

201.01--Description. This work consists of clearing, grubbing, removing and disposing of all items and objects within the limits of the rights-of-way, easement areas or areas shown on the plans or in the contract documents which are not designated to remain or to be removed in accordance with other provisions of the contract. This work shall also include the preservation of all vegetation, objects or materials designated to remain or to be salvaged, and the removal and satisfactory disposal of obstructions and salvable material when their removal and disposal is not otherwise provided in the contract. The requirements for removal and disposal shall be in accordance with the provisions and requirements of Subsections 104.05 and 107.25, and Section 202.

When the contract proposal does not include an item of clearing and grubbing, the necessary work shall be performed in accordance with this section and will be considered as a subsidiary obligation of the Contractor under other contract items.

201.02--Blank.**201.03--Construction Requirements.****201.03.1--Clearing and Grubbing.**

201.03.1.1--General. The Engineer will establish rights-of-way, easements, construction lines and designate all trees, shrubs, plants and items to remain.

It is the intent of these specifications that desirable natural growth within the rights-of-way and easements be preserved where practicable. Undesirable growth and other things which detract from the aesthetic value of the completed work or interfere with construction or future maintenance shall be removed. In areas where desirable natural growth is designated to remain, the Contractor shall thin or trim shrubbery and live trees to the extent consistent with the intent of these specifications. Use of methods or equipment which might mar or destroy vegetation designated to remain will not be permitted.

It shall be the responsibility of the Contractor to consider all rights-of-way agreements with the property owners regarding merchantable timber prior to submitting a bid. Merchantable timber conveyed to the State and required to be removed will become the property of the Contractor unless specifically designated otherwise in the contract documents.

All clearing and grubbing necessary for setting construction stakes shall be completed a satisfactory distance ahead of the grading operations.

201.03.1.2--Clearing and Grubbing. Surface objects, trees, stumps, roots and other protruding or underground obstructions, not designated to remain, shall be cleared and grubbed, including mowing, as required. Undisturbed stumps shall be cut off no more than six inches above the ground line or water level. Undisturbed stumps and non-perishable solid objects which will be a minimum of three feet below subgrade or slope of embankment may be left in place when authorized by the Engineer. Stumps and non-perishable solid objects in swampy or wooded areas where mowing is not anticipated may be authorized to remain, provided they do not extend more than six inches above the ground line or low water level.

The Engineer may also permit sound stumps to remain outside the construction limits where mowing is anticipated provided they are cut off flush with or below the surface of the final ground line.

Except in areas to be excavated, stump holes and other holes from which obstructions are removed shall be backfilled with suitable material and compacted to the satisfaction of the Engineer.

All operations shall be conducted in such a manner as to prevent damage to adjacent property and items that are to remain on the right-of-way.

Burning shall be in accordance with the requirements of Subsection 107.22.2.

If not burned, materials and debris shall be removed from the right-of-way and disposed of outside the limits of view from any public road or facility. Locations for disposal shall be obtained by the Contractor in accordance with Subsection 104.05.

Low hanging tree branches which will interfere with maintenance of the roadside shall be removed, and unsound or unsightly branches on trees or shrubs designated to remain shall be removed as directed. Branches of trees extending over the roadway shall be trimmed to give a clear height of at least 20 feet above the roadway surface. All trimming shall be done by skilled workmen and in accordance with good tree surgery practices. An asphalt base paint or sealer prepared specifically for tree surgery shall be applied to cut or scarred surfaces of trees and shrubs.

201.03.1.3--Clearing and Grubbing of Bridge Sites. When separate and concurrent grading and bridge contracts are to be in progress between the termini of construction, clearing and grubbing of the bridge site shall be the responsibility of the grading Contractor, unless the bridge contract contains a bid item for clearing and grubbing.

When there is not a coincidental grading contract or a bid item for clearing and grubbing in the bridge contract, clearing and grubbing of the bridge sites shall be

considered incidental to and included in the price bid for the bridge items.

201.03.2--Random Clearing and Grubbing, and Random Clearing. This work consists of random clearing and grubbing areas designated on the plans or in the contract documents. Random clearing and grubbing will be performed in the designated areas in accordance with the requirements of Subsection 201.03.1.

Random clearing will consist of removing all things such as trees and scrubs within areas shown on the plans or in the contract documents where grubbing is not needed. Examples of such areas may be limits of fencing, site flares, safety zones, etc.

When random clearing is required in areas such as safety/clear zones, cutting shall be approximately flush with the ground. Grubbing will not be permitted in these areas. Stumps are to be cut approximately flush with the ground, but in no case shall stumps extend more than two inches above the ground line. This work also includes the removal and proper disposal of the cut material off of the right-of-way, or it may be chipped or shredded by mechanical means and mulched on the right-of-way to the satisfaction of the Engineer. Material and debris which is removed from the right-of-way shall be disposed of outside of limits of view from any public road, street, park or other such public facility at locations obtained by the Contractor in accordance with Subsection 104.05 and Section 202.

201.04--Method of Measurement. Any mowing required as a part of the clearing and grubbing, random clearing and grubbing, or random clearing operations will not be measured for payment.

Unless otherwise noted, clearing and grubbing, random clearing and grubbing, or random clearing will be measured as follows.

201.04.1--Lump Sum Basis. The area included under this item will be the entire area within the right-of-way lines shown on the plans. No measurement will be made except when the area of the right-of-way is increased or decreased from that shown on the plans at the time bids are received. In this case, the lump sum contract price will be adjusted in the same ratio that the area of the right-of-way is increased or decreased.

201.04.2--Area Basis. The area included under this item will be measured in acres. Measurement will only be made for the area(s) actually cleared or cleared and grubbed and will not include areas for which payment is made under another item. The clearing of grass, weeds, roots, farm crops, and scattered small bushes will not be measured for payment.

Areas acquired for haul routes, or areas acquired for Contractor use will not be measured for payment, unless noted otherwise in the contract.

201.04.3--Station Basis. The designated areas of random clearing will be measured per station in accordance with the typical sections shown on the plans. This shall apply to the right or left sides of each separate roadway. Separate measurement shall be made for random clearing required and satisfactorily completed on the right or left sides of each separate roadway.

201.05--Basis of Payment. Clearing and grubbing, random clearing and grubbing, or random clearing, measured as prescribed above, will be paid for at the unit price bid as follows.

201.05.1--Lump Sum Basis. The work under this item will be paid for at the contract lump sum price or adjusted lump sum price in accordance with the above provisions which shall be full compensation for completing the work.

201.05.2--Area Basis. The work under this item, measured as prescribed above, will be paid for at the contract unit price per acre which shall be full compensation for completing the work.

201.05.3--Station Basis. The work under this item, measured as prescribed above, will be paid for at the contract unit price per station which shall be full compensation for completing the work.

The price for clearing and grubbing, or random clearing, shall include the cost of continuous maintenance of traffic and protective services as required by the Traffic Control Plan included in the contract. This shall include all required individual traffic control.

Payment will be made under:

- 201-A: Clearing and Grubbing - lump sum
- 201-B: Clearing and Grubbing - per acre
- 201-C: Random Clearing and Grubbing - per acre
- 201-D: Random Clearing - per station or acre

**SECTION 202 - REMOVAL OF STRUCTURES
AND OBSTRUCTIONS**

202.01--Description. This work consists of the removal and satisfactory disposal of all buildings, fences, structures, old pavements, abandoned pipe lines and other obstructions which are not designated to remain or to be removed and disposed of under other provisions of the contract or under separate contracts or agreements as referenced in Subsection 104.05. This work also consists of

necessary excavation incidental to the removal of structures and obstructions and backfilling the resulting cavity.

202.02--Blank.

202.03--Construction Requirements.

202.03.1--General. The Contractor shall preserve and protect all structures, fences, public and private utilities and improvements, above or below the ground, which are to remain or be removed by others as set out in Subsection 104.05. Unless specified, removal or adjustment of these items will not be the responsibility of the Contractor. However, the Contractor shall arrange and conduct operations to conform to the requirements set out in Subsections 105.06 and 105.07.

The Contractor shall raze or remove and satisfactorily dispose of all buildings, structures, fences and other obstructions except those items indicated to remain or be otherwise removed and disposed of under other provisions. Basements or cavities left by structure removal shall be filled to the level of the surrounding ground, compacted as directed, or if within the limits of construction, compacted in accordance with Subsection 203.03.

All materials not designated for salvage shall be disposed of by the Contractor in accordance with Subsections 201.03.2 and 104.05.

The use of explosives is not permitted unless approved by the Engineer. Blasting, if permitted, or other operations necessary for the removal of an existing structure or other obstruction which may damage new construction shall be completed prior to constructing the new work. The Contractor shall employ methods of removal that will ensure new work, items to remain or materials to be salvaged will not be damaged. Reference is made to Subsections 107.11 and 107.12 regarding this work.

202.03.2--Salvage. All material designated for salvage shall be removed, without unnecessary damage, in sections or pieces which may be readily transported. The material shall be stored by the Contractor at designated sites within the project limits or at special locations as designated in the contract.

202.03.3--Removal of Bridges, Culverts and Other Structures. Bridges, culverts and other structures that are in use shall not be removed until the traffic is satisfactorily accommodated.

Unless otherwise directed, existing structures shall be removed to at least one foot below the final ground line or mudline. The removal of a bridge located in a navigable stream shall be subject to the requirements set out in the permit authorizing construction of the new structure.

Unless designated on the plans or in the contract documents to be removed and salvaged, all structural steel, timber and other bridge materials shall become the property of the Contractor. It shall be removed from the site before completion of the work and proper allowance for its value shall be taken into account in the bid price of the item involved. If the structure is to remain the property of the State, steel or timber bridges shall be carefully dismantled without unnecessary damage. Steel members shall be match marked and all salvaged material shall be stored as specified in Subsection 202.03.2.

When required on the plans or in the proposal, concrete which is suitable for riprap shall be salvaged and stockpiled or otherwise disposed of in accordance with Subsection 202.03.5.

All removals shall be in accordance with the provisions of Subsection 104.05.

202.03.4--Removal of Pipe. All pipe lines designated to be salvaged or relaid shall be carefully removed and every reasonable precaution taken to avoid breaking or damaging. Pipes designated to be relaid shall be removed and stored when necessary to prevent loss or damage before relaying. The Contractor shall replace without extra compensation all sections lost from storage or damaged by negligence or improper methods to the extent its reuse is deemed by the Engineer to be unsatisfactory. Pipes not designated to be salvaged or relaid shall be disposed of by the Contractor in accordance with Subsections 201.03 and 104.05.

202.03.5--Removal of Pavement, Sidewalks, Curbs, Etc. When required on the plans or in the proposal, concrete pavement, sidewalks, curbs, gutters, etc. designated for salvage shall be broken into pieces not exceeding 150 pounds and stockpiled at locations designated by the Engineer within the project limits or at special locations as designated in the contract. All non-salvaged materials shall be disposed of by the Contractor in accordance with Subsections 201.03 and 104.05.

202.04--Method of Measurement. Removal of Obstructions - lump sum, will include all structures and obstructions encountered within the right-of-way and easement areas except items which are to be measured on a unit basis.

Where the proposal stipulates specific items on a unit basis, measurement will be made by the unit.

The length of pipe removed will be the product of the number of commercial lengths and the nominal laying length.

Traffic stripe removal will be measured by the linear foot from end-to-end of individual stripes. Measurement will be made along the surface of each stripe and will not include nominal skip intervals. Stripes more than six inches in width will be converted to equivalent lengths of six-inch stripe. Legend will be

measured for payment by the square yard. When provisions are not included in the contract for legend removal by the square yard, the removal area will be converted to equivalent lengths of six-inch stripe.

202.05--Basis of Payment. Removal of Obstructions will be paid for at the contract lump sum price which shall be full compensation for removing and disposing of the obstructions in accordance with the provisions of the contract.

Specific obstruction items stipulated for removal and disposal under 202-B will be paid for at the contract unit price which shall be full compensation for completing the work.

Payment will be made under:

- 202-A: Removal of Obstructions - lump sum
- 202-B: Removal of Item - per each, linear foot,
square yard,
or cubic yard

SECTION 203 - EXCAVATION AND EMBANKMENT

203.01--Description. This work consists of excavation and embankment required for roadways, ditches, channel changes and borrow material, preparation of subgrades and foundations, construction of embankments and other utilization or disposal of materials excavated, and the compaction and dressing of excavated areas and embankments. This work shall also consist of any required site grading in accordance with the details in the plans and/or as directed by the Engineer. The work of excavation for structures is covered separately under Section 206 and not included under this section.

203.01.1--Unclassified Excavation. Unclassified excavation will consist of all excavation materials of whatever character encountered in the work except for those classes of excavation for which separate pay items are provided.

203.01.2--Rock Excavation. When shown as a pay item, rock excavation will consist of material which cannot be excavated without blasting and shall also include large boulders and detached stones having volumes of one-half cubic yard or more. The use of the words "rock," "boulders," "stone," or synonyms of these words appearing elsewhere on the plans, soil profile or these specifications does not imply that these materials may be included under this classification unless so indicated in the contract proposal.

The Contractor shall immediately notify the Engineer when rock excavation is encountered during the progress of the work so the necessary measurements may

be made for determining the volume removed.

203.01.3--Muck Excavation. Muck excavation will consist of the excavation, removal and disposal of natural deposits of soils and organic matter in accordance with the provisions of Subsection 203.03.7. Muck excavation shall not be identified by visual means but will be sampled and tested, at a frequency determined by the Engineer, to verify its classification. Muck excavation is defined as a saturated soil having an organic content of at least six percent (6%) as determined by Mississippi Test Method MT-29, or AASHTO Designation: T 267.

It is the intent that all areas of muck excavation will be located and defined during the design phase of a project. However, if additional areas of questionable material are found during construction, the material shall be tested to see if it is a saturated soil having an organic content of six percent (6%) or more before it is considered muck. If the material is defined as a muck, based on testing, the method of removal should not be an issue and the material should be paid for as 203-D, Muck Excavation.

Excavated material not meeting the herein established requirements for classification as muck excavation shall be used, measured and paid for under the pay item in which the material is being used.

In extreme cases, in non-organic areas where all efforts to drain the area and/or dry the material have proved unsuccessful, the Project Engineer, in consultation with the District Materials Engineer and District Construction Engineer, shall make the determination as to whether the material will be classified as muck excavation or unclassified excavation.

Removal of muck excavation shall be in accordance with the requirements of Subsection 104.05.

203.01.4--Borrow Excavation. Borrow excavation will consist of approved material required for the construction of embankments or other portions of the work and shall be obtained from approved sources outside the right-of-way except as provided in Subsection 203.03.3. Unless otherwise provided in the contract, the Contractor shall make arrangements for obtaining borrow and pay all costs involved. Contractor-furnished borrow shall meet the requirements of Subsections 106.02.2 and 703.21.

203.01.5--Channel Excavation. When shown as a pay item, channel excavation will consist of excavation and disposal of all material from widening, deepening or straightening of an existing channel, or construction of a new channel. The Contractor shall furnish a disposal area unless otherwise provided in the contract. Material designated as channel excavation and used in the roadbed or other required embankment construction will be measured for payment as channel

excavation only.

203.01.6--Excess Excavation. When shown as a pay item, excess excavation will consist of excavation which cannot be satisfactorily used or disposed of within the right-of-way. Exclusive of muck excavation, excess excavation may include any type, kind, or class of excavation which the Engineer determines must be removed from the right-of-way. It will not include any excess caused by the Contractor importing too much excavation from sources outside the roadway structure; in such case, the excess excavation shall be removed from the right-of-way without cost to the State.

Unless otherwise indicated in the contract, the Contractor shall provide a disposal area for excess excavation.

Removal of excess excavation shall be in accordance with the requirements of Subsection 104.05.

203.01.7--Surplus Excavation. When shown as a pay item, surplus excavation will consist of excavation within the right-of-way which is in excess or unsuitable for embankments but can be satisfactorily used or disposed of within the right-of-way.

203.02--Blank.

203.03--Construction Requirements.

203.03.1--General. Excavation and embankment operations may be started at the location and in the sequence approved by the Engineer when:

- (a) sufficient clearing and grubbing has been completed and accepted;
- (b) the work has been cross sectioned and slope staked;
- (c) installation of required pipes, culverts, and approved backfills are complete;
- (d) the site has been prepared in accordance with these specifications and
- (e) the Contractor is aware of proper methods of haul and disposal of material.

Excavations and embankments shall be finished to reasonably smooth and uniform surfaces. No material shall be wasted without permission of the Engineer. Excavation operations shall be conducted in a manner that material outside the construction limits will not be unnecessarily disturbed.

Where plating with topsoil is contemplated, either in cut or fill sections, appropriate adjustment shall be made in the graded section during construction so that the finished section after plating will conform to the typical sections shown on the plans.

Unless otherwise specified, rock larger than three inches shall be removed from the roadbed to a minimum depth of eight inches below subgrade and backfilled with material designated on the plans or approved by the Engineer. Care shall be taken that undrained pockets are not left in the surface of rock. Rock removed more than 12 inches below subgrade will not be measured for payment and backfilling in excess of 12 inches will be at the expense of the Contractor. Removal of boulders and subsequent backfilling are excluded from the 12-inch limitation.

Borrow material should not be placed until excavation from the roadway has been utilized as shown on the plans. Excess material determined to have been caused by the Contractor importing too much excavation from sources outside the roadway shall be removed from the right-of-way in accordance with Subsection 104.05 unless permission is given by the Engineer that the material may be disposed of within the right-of-way. In either case, the volume of excess material will be measured by the method deemed most appropriate by the Engineer under the provisions of Subsection 109.01 and deducted from measured quantities. The Contractor shall not excavate beyond the dimensions and elevations established or approved, and no material shall be moved prior to the staking out and cross-sectioning of the site.

If borrow material is to be measured for payment in its original position (FM), the finished borrow areas shall be left in a condition suitable to accurately measure the material used.

Additional requirements shall be those applicable conditions governing the use of local materials as set out in Section 106.

Obliteration of old roadways shall include all operations necessary to incorporate the old roadway into the new roadway or into the surrounding right-of-way in a way that will provide a pleasing appearance from the new roadway. Unless other pay items are provided, roadway obliteration will be paid for as unclassified excavation.

When excavating operations encounter the remains of prehistoric dwelling sites or other artifacts of historical or archeological significance, the operations shall be temporarily discontinued. The Engineer will contact appropriate authorities to determine their significance and appropriate disposition. When directed by the Engineer, the Contractor shall excavate the site in a manner to preserve the artifacts encountered, or aid in the determination of significance and disposition, and when ordered, shall remove them for delivery to the custody of the proper

State authorities. Such excavation and removal will be considered and paid for as Extra Work.

Where excavation to grade results in a foundation, subgrade, or slope of unsuitable soil, the Engineer may require the Contractor to remove unsuitable materials and backfill to the required grade with approved material. Slides or other soil failures shall be removed by the Contractor unless their removal is waived by the Engineer. The Contractor shall conduct operations in such a way that the Engineer can take the necessary cross sections before backfill is placed.

The Engineer may designate as unsuitable those soils which, at the proper moisture content, cannot be processed to the required density and stability. All unsuitable material shall be disposed of as specified or directed.

When the Engineer orders or the contract requires excavation to be handled more than one time prior to final placement, such as topsoil to be stockpiled and reserved for later use, payment will be made at the contract unit price for the class excavation involved for each handling approved by the Engineer, or it will be paid as another item of work for the final handling when so specified.

203.03.2--Topsoil. Where the salvaging and stockpiling of topsoil is specified, this operation shall be completed before beginning excavation of the underlying material.

203.03.3--Borrow Excavation from Within the Right-of-Way. When the contract indicates borrow excavation to be paid for as final measure-embankment (FME), the plans may also identify certain estimated excavation volumes by the symbol ESFE (Estimated State Furnished Excavation). Suitable quantities of ESFE may be used by the Contractor without charge in the construction of embankments to be measured FME.

Quantities of ESFE shown on the plans are for the Contractor's information only and may vary or may be varied by the Engineer. The change in quantity shall not be cause for additional compensation.

Excavation designated as ESFE is required to be performed and will not be measured in its original position. ESFE suitable for use in embankment or other features of the work shall be used and will be included in measured quantities of borrow excavation (FME). Any materials indicated as ESFE which are found to be unsuitable shall be removed and disposed of as provided elsewhere in the contract.

203.03.4--Construction of Bridge Approaches. The construction of "spill through" embankments and approaches shall be the responsibility of the grading Contractor. The existence of a separate contract awarded for bridge construction will not alter this responsibility.

The grading Contractor shall construct the bridge approaches to subgrade elevation and extending a minimum of 100 feet from each bridge end as soon as practicable. All bridge end slopes shall be finished to the lines and grades specified except the allowable tolerance for initial construction of bridge end slopes to be paved is plus six inches.

The bridge Contractor shall drive the piling through the fill, complete the end bents, end spans, and slope paving as soon as practicable after the bridge end fills have been placed in order that the grading may be completed by the grading Contractor. The bridge Contractor is responsible for the final shaping of the "spillthrough" embankment for placement of slope paving or riprap.

203.03.5--Excavation Operations. Excavation operations shall be so conducted as to minimize the loosening of materials outside the required slopes or below the indicated grade. No payment will be made for the removal, disposal or replacement of material determined to be loosened or undercut through carelessness or negligence on the part of the Contractor. Neither will payment be made for excavation which is used for purposes other than designated except as provided in Subsection 104.06.

When practicable, excavation and disposal of the material shall be conducted in such a manner that the most suitable material will be placed in the top courses of embankments. Also, adequate drainage which will conform to the finished drainage system shall be maintained.

All earth cut slopes shall be dressed to smooth and uniform surfaces to conform to the specified sections. The allowable horizontal tolerance at subgrade elevation will be five-tenths of a foot. The allowable tolerance from staked cut slopes will be plus or minus five tenths of a foot horizontally for each 10 feet of depth. Allowable vertical tolerances at subgrade elevation shall be in accordance with the tolerances set out in Section 321.

Care shall be taken to avoid overshooting of material when blasting. All rock cut slopes shall be left with a reasonably uniform surface, and all loose, shattered or overhanging rock shall be removed.

203.03.6--Muck Excavation. The depth and width of muck excavation will normally be shown on the plans. The excavation and subsequent basement soil formation shall be completed as soon as practicable in order to obtain maximum consolidation prior to final shaping of the subgrade and subsequent construction of the pavement structure. When directed by the Engineer, other unsatisfactory foundation material beneath or immediately adjacent to the muck shall be removed and disposed of as muck excavation.

Excavation of muck shall proceed ahead of backfilling or embankment operations for the full width and depth shown on the plans or as directed.

Placing of embankment material in the excavated area by backdumping may be permitted when the Engineer determines this method of placement to be satisfactory. In this case, placement shall immediately follow the muck removal, and where deemed desirable, the fill shall be constructed forward in a wedge shape with as much of a surcharge above grade as practicable to afford maximum displacement of the remaining muck. Pressure developed on the advancing toe of the embankment by the displaced muck shall be relieved by excavating and removing the muck. Otherwise, embankment construction shall be performed in accordance with the provisions of Subsection 203.03.8.

The Contractor shall take necessary precautions to insure that stream channels and drainage ditches will not be filled by movement of muck. Displaced materials adjacent to the roadway shall be leveled or disposed of as specified. In any case, the material shall be left in such a manner that it will not present an unsatisfactory appearance, interfere with essential drainage or prevent proper embankment formation.

203.03.7--Disposal of Unsuitable, Surplus, Channel and Excess Excavation.

All material encountered in excavation within the right-of-way which is unsuitable for use in the work shall be removed and disposed of as specified in the contract or as directed. Unsuitable material shall be understood to be any material which, at the proper moisture content, cannot be processed to the required density and stability.

The Contractor will be paid for unsuitable material ordered excavated and disposed of and the required backfill material at the respective contract prices except when the unsuitable material was placed under the contract.

Unless otherwise specified, the Contractor shall provide at no additional costs to the State the location for the disposal of muck and excess excavation and shall furnish the Engineer with two signed copies of the release as provided in Subsection 104.05. Removal of muck and excess excavation shall be in accordance with the requirements of Subsection 104.05.

Surplus excavation as defined in Subsection 203.01.7 shall be used for widening of embankments, flattening slopes or at other locations within the right-of-way for the purpose indicated. If there is more surplus excavation than can be effectively used within the right-of-way, the Engineer may reclassify the excavation as excess excavation as defined in Subsection 203.01.6 when the contract contains a bid item for excess excavation or order its disposal as extra work.

Unless specified for use in embankments, channel excavation may be used to fill old channels when so designated on the plans and to fill washes and gullies or wasted as directed by the Engineer. It shall be spread and leveled or otherwise shaped to blend with the adjacent terrain and shall not obstruct drainage, interfere

with the property rights of others or present an unsatisfactory appearance.

203.03.8--Embankment Construction.

203.03.8.1--General. Embankment construction shall consist of constructing roadway embankments, dikes, placing and compacting of approved material where unsuitable material has been removed, backfilling of structures where not otherwise provided for and placing and compacting embankment material in holes, pits or other depressions. This work shall also consist of preparation of the areas upon which embankments are to be constructed. Only approved materials shall be placed in embankments and backfills. Unsuitable or perishable materials such as rubbish, sod, brush, roots, logs, stumps after removal, heavy vegetation, sawdust, etc., shall not be incorporated in embankments. Rocks, broken concrete, or other solid material shall not be placed in embankment areas where piles are to be driven.

Special materials for inundated areas, filter beds, etc., or special backfill may be specified elsewhere in the contract.

203.03.8.2--Preparation of Embankment Areas. Preparation of embankment areas shall be in accordance with one or a combination of the following procedures:

- (a) All grade points shall be undercut and backfilled with suitable material as directed by the Engineer and compacted to the density for the design soil portion of embankments. The material excavated from the undercut, if suitable, shall be used in other portions of the work. The undercut at each grade point shall be approximately three feet below subgrade. The undercut shall be extended a sufficient distance into the cut to provide an undercut grade at the point of intersection with the subgrade of not less than three feet below natural ground. Approved undercut will be measured for payment as excavation.
- (b) Where an old road surface containing granular materials or surface treatment is less than three feet below subgrade, the old road shall be scarified as directed. The scarified material shall be compacted to the density specified for the design soil portion of the embankment prior to placing additional material.
- (c) Unless otherwise specified or directed by the Engineer, all sod, vegetation and unsuitable soil shall be removed from the surface upon which the embankment is to be constructed when the height of the embankment to subgrade will be three feet or less. The cleared surface shall be thoroughly mixed by plowing, scarifying or disk-harrowing to a depth of at least six inches. The area shall then be compacted to the density specified for the design soil portion of the embankment.

The removed vegetation and unsuitable soil shall be disposed of as directed. No measurement for payment will be made unless the Engineer requires that the material be loaded and hauled for use or disposal in another area. In this case, measurement for payment will be made as provided in Subsection 203.04 and haul will be paid as provided in Section 205. No direct payment will be made for the plowing, scarifying or disk-harrowing.

- (d) In areas where the height of embankment to subgrade is to be greater than three feet, all material determined by the Engineer to be unsuitable as a foundation of the embankment shall be undercut and disposed of as directed. All sod on other areas shall be thoroughly disk-harrowed before construction of the embankment. Approved undercut will be measured for payment as excavation and haul will be paid as provided for in Section 205. No direct payment will be made for the disk-harrowing.
- (e) Where embankment is to be constructed against existing roadway slopes or on hillsides, the slopes which are steeper than 6:1 shall be continuously benched as the new work is constructed on the slope. Benching shall be of sufficient depth and width to permit operation of the construction equipment. Each horizontal cut shall begin at the intersection of the original ground or slope and the vertical side of the previous cut. Suitable material thus cut out shall be recompacted along with the new embankment material and will not be measured for payment.

203.03.8.3--Embankment Formation. After the area has been prepared as specified, the embankment shall be constructed in full-width layers parallel to the finished grade.

Except as herein provided, the non-compacted thickness of each layer shall not exceed eight inches and shall be spread, shaped and compacted to the required density and stability. The completed embankment shall conform to the line, grade, and cross-section.

The required stability in embankment construction shall be that which the Engineer determines can be reasonably obtained at the proper moisture content for the material being placed. Sponginess, shoving or other displacement under heavy equipment will be considered prima facie evidence of the lack of stability.

Direct casting or similar methods will not be permitted unless authorized in writing by the Engineer. When direct casting is authorized, all material shall be moved from the point where it is deposited, spread and compacted in uniform layers as specified herein.

203.03.8.4--Basement Soils. Reference is made to Figure 1 at the end of Subsection 101 regarding basement soils. In low, swampy ground which will not support the weight of hauling equipment, the Engineer may permit the bottom portion of the embankment to be built in a uniformly distributed layer of sufficient thickness to support the construction equipment. However, this method will not be permitted in any portion of the embankment within three feet of the subgrade.

Where the embankment material is from an inconsistent soil deposit, construction shall be performed so as to eliminate pockets or strata of varying materials. Each layer shall be disk-harrowed and heavily bladed for its full depth; or moved from its position of deposit by appropriate equipment; or processed by other means to the extent necessary to eliminate pockets or stratification of the embankment materials. The layer shall then be shaped and compacted in accordance with these specifications.

Rock shall be distributed over the embankment area to avoid bridging, nests or pockets, and all voids shall be completely filled with earth or stone fragments and compacted. Where only occasional boulders are encountered, they shall be placed near the outer slopes in lower portions of the embankment.

Where the excavated material consists predominately of rock fragments of sizes that cannot be placed in layers of the thickness specified without crushing, pulverizing or further breaking down of pieces resulting from excavation methods, the material may be placed in layers not exceeding the thickness of the approximate average size of the rocks, but in no case to exceed three feet. The balance of the embankment shall be composed of suitable material placed in layers not exceeding eight inches in loose thickness and compacted as specified.

203.03.8.5--Design Soils. Reference is made to Figure 1 at the end of Subsection 101 regarding design soils. Each layer of the design soil shall be disk-harrowed and heavily bladed for its full depth, or processed by other approved means to the extent necessary to provide a layer of material reasonably uniform in character. Each layer shall then be shaped and compacted in accordance with these specifications.

203.03.8.6--Backfill and Embankment Formation Adjacent to Structures. Backfilling around structures shall not start until permission has been granted by the Engineer as referenced in Subsection 601.03.6.3. After approval is given to proceed, the work shall be performed under the supervision of the Engineer or the Engineer's designated representative.

Material used shall be suitable material obtained from structure excavation, roadway and drainage excavation or other designated material. The material shall be approved before placement and shall be the best available from the source. It shall preferably be sandy or loamy non-plastic material and free from

large lumps, clods, rock or other objectionable matter. Adequate provision shall be made for thorough drainage of all backfilling.

The backfill material shall be deposited in uniform and parallel layers not to exceed eight inches of loose material on each side of box bridges, culverts or other structures. Each layer shall be processed by approved methods for its full depth and to the extent necessary to provide a layer of material reasonably uniform in character and shall be so placed and compacted that drainage of the layer will be away from both the longitudinal and the transverse axes of the structure. In addition, the backfill for abutments, retaining walls, wing walls or other structures or sections thereof shall be built in layers with each layer being constructed for the full length of the unit and special precaution shall be taken to prevent any wedging action against the structure.

The material for each layer shall be uniformly compacted with approved mechanical equipment or self-powered mechanical tampers to not less than the density required in the adjacent embankment. The work shall be conducted so as to form a berm of compacted soil of sufficient width on each side of the structure. The berm at the top of the structure shall be at least six feet in width. The slopes of the backfill shall not be steeper than 2:1 at any point. Unless otherwise specified, backfilling shall continue as applicable to the level of the original ground or to an elevation at least one foot above the top of the structure or to the top of the graded section when less than one foot of cover is provided.

The work shall be conducted in a manner that the Engineer can make the necessary tests for compaction as the work progresses.

The Contractor shall repair, restore with new work or make good without extra compensation all damage to the structure as a result of the backfilling operation.

Payment for this construction shall be included in the contract unit price for the material with which backfill is made.

203.03.8.7--Compaction of Embankments. All embankment material shall be at the moisture content determined to be proper for the particular material being placed so that the resulting work will be both dense and stable.

It shall be the Contractor's responsibility to maintain the proper moisture content during compaction operations and the Engineer may require additional moisture or drying as necessary without additional compensation.

The material shall be compacted until the required density, determined in accordance with Subsections 700.03 and 700.04 has been attained and the embankment is stable.

Acceptance of compaction will be on a lot basis. A lot size will be based on the

Contractor's hourly production rate as set out in Department's SOP.

For basement and design soils, the required density shall be 95.0 percent and 98.0 percent, respectively. If a density test is within minus two percent (-2.0%), 93.0 to 95.0% or 96.0 to 98.0%, of the required density, a verification test will be performed and the average of the two tests will be the test value for the lot. If this test value does not meet the required density (95.0 or 98.0%), the lot shall be rejected. If the original test value exceeds minus two percent (-2%) of the required density, no verification test will be performed and the lot shall be rejected.

Acceptance of compaction for structural backfill will be considered a separate frame of work. The backfill at each structure up to a depth of five feet will be considered a lot. For long structures, the Engineer may specify that the backfill be divided into smaller lots. Each lot will be divided into four approximately equal sublots with two density tests taken at random on each side of the structure. The single test and the lot average shall conform to the required densities set forth above for basement soils or design soils as applicable.

The Contractor shall make allowance for shrinkage and compaction in the construction of embankment.

203.03.8.8--Tolerances. The tolerances shown below as allowable shall not prevent the work from meeting the requirements of Subsection 105.03.

Allowable vertical tolerances for design soils at subgrade elevation shall be in accordance with the tolerances set out in Section 321.

The allowable horizontal tolerance at subgrade elevation will be five-tenths of a foot. The allowable tolerance from staked slopes on fills will be plus or minus five-tenths of a foot horizontally for each 10 feet of fill height except where surplus excavation is required or permitted by the Engineer for widening embankments or flattening slopes. In these cases tolerances will be modified accordingly.

203.03.9--Site Grading. Site grading shall consist of excavating or shaping foreslopes, backslopes, or areas shown on the plans to the satisfaction of the Engineer. When site grading is performed and the yield of material from shaping the designated area is in excess of the material needed, such material will be removed and disposed of as directed by the Engineer. Payment of removed material will be made at the contract price for the class excavation involved.

Clearing and grubbing, if required, shall be included in the bid item for clearing and grubbing. If no bid item for clearing and grubbing is included in the contract, it shall be included in the contract unit price for site grading.

The equipment used to site grade shall be capable of grading the site to a uniform and smooth surface as directed by the Engineer.

203.03.10--Maintenance of Earthwork. The Contractor shall satisfactorily maintain all portions of the work until release of maintenance by the Engineer as referenced in Subsections 105.14, 105.15, 105.16 and 107.17. The Contractor shall replace, restore or reconstruct without extra compensation all portions, including materials, determined by the Engineer to have been displaced or damaged due to carelessness or negligence. Carelessness or negligence may include, but not be limited to, improperly maintained; inadequate drainage; failure to remove forms or obstructions; failure to properly prosecute and complete work within the specified time; neglecting to establish erosion control items in accordance with the provisions of Subsection 107.22 and Section 210 or other avoidable causes for displacement or damages.

203.04--Method of Measurement. Items of excavation listed in the proposal will be measured as set forth herein, unless otherwise stipulated.

203.04.1--Unclassified, Rock, Muck, Channel, Excess and Surplus Excavation. These items will be measured by the cubic yard final measure (FM) or loose vehicular measure (LVM) in accordance with Subsection 109.01. The unit of measurement for each item will be shown on the proposal bid sheets. Excavation identified as ESFE will not be measured for payment as excavation except as provided herein.

Excavation identified as ESFE which is unsuitable for placement in the designated roadway prism may be used to construct berms, flatten slopes, wasted on the right-of-way or disposed of by the Contractor off the right-of-way as directed by the Engineer and will be measured for payment under Pay Item No. 203-A, Unclassified Excavation. When the contract does not include a bid price for unclassified excavation, the ESFE will be measured for payment under Pay Item No. 203-EX, Borrow Excavation (ESFE) (FM) (AH), per cubic yard at a unit price equal to 75 percent of the contract unit price for contractor furnished borrow excavation.

203.04.2--Borrow Excavation-State Furnished. Borrow excavation will be measured in accordance with Subsection 109.01 by the cubic yard FM, FME or LVM. The unit of measure will be shown on the proposal bid sheets. When measurement is by FME, it will include excavation identified as ESFE which has been incorporated into the embankment.

203.04.3--Borrow Excavation-Contractor Furnished. Contractor furnished borrow will be measured in accordance with Subsection 109.01 by the cubic yard FME or LVM. The unit of measure will be shown on the proposal bid sheets. When measurement is by FME, it will include excavation identified as ESFE which has been incorporated into the embankment.

Undercut required by the Engineer prior to placement of embankment material that is suitable for placement in other furnished portions of the embankment will be measured for payment as contractor borrow excavation.

Undercut that is unsuitable for placement in the designated roadway prism may be used elsewhere and measured for payment as provided in Subsection 203.04.1 for unsuitable material identified as ESFE.

203.04.4--Haul. Haul of excavation, when authorized for payment, will be measured in accordance with Subsection 205.04. Unless otherwise provided, haul will not be measured for channel excavation, muck excavation or contractor furnished borrow excavation. Nor will haul be measured for payment of the other excavation items when the pay item description contains the symbol "AH" for absorbed haul.

203.04.5--Site Grading. Site grading, complete and accepted, will be measured by the acre or square yard. Only areas shown on the plans or directed by the Engineer will be considered for measurement of payment.

203.05--Basis of Payment. Excavation items, measured as prescribed above, will be paid for at the contract unit price per cubic yard, square yard or acre, which price shall be full compensation for completing the work.

Payment will be made under:

203-A:	Unclassified Excavation, <u>FM or LVM</u>	- per cubic yard
203-B:	Rock Excavation, <u>FM or LVM</u>	- per cubic yard
203-C:	Blank	
203-D:	Muck Excavation, <u>FM or LVM</u>	- per cubic yard
203-E:	Borrow Excavation, <u>FM, FME or LVM</u> , Class____	- per cubic yard
203-F:	Channel Excavation, <u>FM or LVM</u>	- per cubic yard
203-G:	Excess Excavation, <u>FM or LVM</u>	- per cubic yard
203-H:	Surplus Excavation, <u>FM or LVM</u>	- per cubic yard
The symbol "AH" may be added to the pay item descriptions as provided in Subsection 203.04.4.		
203-I:	Site Grading	- per square yard or acre

Material Furnished by Contractor:

203-EX: Borrow Excavation, AH, FME or LVM, Class_____ - per cubic yard

203-EX: Borrow Excavation, ESFE, FM, AH* - per cubic yard

* This pay item is not to be included on the plans or contract proposal.

SECTION 204--GEOGRID REINFORCEMENT OF EMBANKMENT SLOPES AND SUBGRADES

204.01--Description. This work shall consist of furnishing and installing geogrid for reinforcement of embankment slopes and/or subgrades as shown on the plans and in conformance with these specifications.

204.02--Material Requirements. The geogrid shall meet the requirements of Subsection 714.15.

204.03--Construction Requirements.

204.03.1--Preparation of Design Grade of Geogrid.

204.03.1.1--Preparation of Foundation Soil. An embankment site that is to receive geogrid reinforcement upon the foundation soil shall be cleared and graded to establish a relatively smooth surface. Trees and stumps are to be cut off at the ground line and sawdust or sand placed over these areas to provide a cushion for the geogrid.

204.03.1.2--Preparation of Basement Soils. An embankment that is to receive geogrid reinforcement located within the basement soil portion of the embankment shall be brought up to the proper grade as shown on the plans and compacted to the required density. The surface shall be left rough so as to provide for a good bond with the next embankment lift above the geogrid.

204.03.1.3--Preparation of Design Soils or Subgrades. A design soil or subgrade which is to receive geogrid shall be shaped and compacted to the required density thus providing a smooth finish, free of loose material and sharp objects.

204.03.2--Geogrid Installation. Geogrid shall be placed coincidently with the compacted lift nearest the design elevation shown on the plans. No partial or half-lift thicknesses are required; however, at no time shall the placement elevation deviate by more than one foot from the design grade.

Correct orientation of the geogrid shall be verified by the Engineer.

Geogrid shall be secured in-place to prevent movement while being covered.

204.03.3--Overlaps and Joints.

204.03.3.1--Uniaxial Geogrids. Uniaxial geogrid shall be placed in continuous longitudinal strips in the direction of main reinforcement and adjacent strips do not need to be overlapped. However, if the Contractor is unable to complete a required length with a single continuous length of geogrid, a joint may be made with the Engineer's approval. This joint shall be made for the full width of the strip by interlacing over and under the main reinforcing strands using a solid rod or hollow pipe of similar material and strength. No end joints will be allowed in any two adjacent strips or within 10 feet of the face of the embankment or, in the case of a spill through slope, in front of the abutment. In the event that the length of geogrid reinforcement is greater than the roll length, then end joints will be allowed in adjacent strips, but they cannot be within 75 feet of one another as measured along the length of the strip. Every effort should be made to keep the number of end joints to a minimum and widely spaced throughout the placement area.

204.03.3.2--Biaxial Geogrids. Biaxial geogrids shall be overlapped three (3) feet between adjacent strips and four (4) feet at the ends except where otherwise noted on the plans and/or in the contract documents.

204.03.4--Placement of Fill over Geogrid. Fill placement shall conform to the requirements of Section 203. Extreme care shall be taken to prevent slippage of the geogrid during fill placement. The fill shall be back dumped and spread on the geogrid in uncompacted lifts of at least six (6) inches before equipment is allowed to continuously operate over it. At no time will tracked equipment be allowed to operate directly upon the geogrid. Rubber tired equipment will be allowed to pass over uncovered geogrid at speeds of less than 5 mph as directed by the Engineer. Any geogrid damage caused by fill placement or equipment movement over the geogrid will be uncovered and repaired as directed by the Engineer at no additional cost to the State.

204.04--Method of Measurement. Geogrid of the type specified will be measured by the square yard of surface area covered. Any overwidth of geogrid installed and additional material required for laps or damage repairs will not be measured. No separate payment shall be made for shipping, handling, storage, protection, fabrication, securing pins or installation, the cost of which shall be included in the contract price for geogrid.

204.05--Basis of Payment. Geogrid, measured as prescribed above, will be paid for at the contract unit price per square yard, which price shall be full compensation for furnishing and placing the geogrid, pins, lapping, joints, repairs, maintaining the geogrid until covered, and satisfactorily completing the work.

Payment will be made under:

204-A: Geogrid, Type _____

- per square yard

SECTION 205 - HAUL

205.01--Description. When the contract contains a pay item for haul, it shall consist of transporting excavated material from its original position to its final location in the work. Haul is designated as Haul of Unclassified Excavation and Haul of classified Excavation.

205.02--Blank.

205.03--Blank.

205.04--Method of Measurement. Haul of excavation will be measured for payment only when the bid proposal contains a pay item for haul. The pay item will identify the excavation item for which haul is to be measured.

Haul will be measured on a distance-volume or distance-weight basis. The distance being 100-foot stations measured along the stationed control line of the project, and the volume or weight measured in the same manner as the excavation item.

In computing haul, it will be assumed that excavated material, including structure excavation, will be hauled the minimum distance and placed in the nearest embankment unless otherwise specified or directed. Cross-haul, when specified or directed by the Engineer, will be measured for payment.

Haul will be computed by multiplying the units of excavation by the average distance it is hauled.

When excavation is shown on the plans and in the proposal to be measured FM, computation of haul will be based on balanced final excavation and embankment quantities determined from final cross-sectional measurements.

A balanced section will be considered as being between two points across which no excavation is hauled. A shrinkage factor will be determined for each balanced section to convert each embankment quantity to the excavation quantity required to construct the embankment.

The center of volume for the cut will be the point where the accumulated yardage equals one-half the total excavation, and the center of volume for the embankment will be the point where the accumulated yardage equals one-half the total embankment. Within each balanced section, the average haul will be

computed along the control line of the project as the distance between the center of volume for the excavation in its original position and the center of volume for the corresponding embankment in its final position.

Embankment and excavation will be considered in sections not exceeding approximately 1,000 feet in length. The center of volume of each section will be determined as set out in the previous paragraph and used in determining the average haul distance.

Structure excavation used in construction of embankments will be included in the excavation quantities of each balanced division, and haul thereof will be determined as set out above.

When the plans and proposal provide for haul of excavation measured as plan haul distance (P.H.D.), the final quantity for Haul of Excavation will be adjusted proportionate to the increase or decrease in the total excavation quantity determined from final cross-sectional measurement of accepted work.

205.05--Basis of Payment. Haul of excavation, measured as prescribed above, will be paid for at the contract unit price per station yard, which shall be full compensation for completing the work.

Payment will be made under:

- 205-A: Haul of Unclassified Excavation, FM or LVM - per station yard
- 205-B: Haul of Classification Excavation,
FM, FME or LVM - per station yard
- 205-C: Haul of Classification Excavation,
FM, FME or LVM, PHD - per station yard

**SECTION 206 - STRUCTURE EXCAVATION
FOR CONDUITS AND MINOR STRUCTURES**

206.01--Description. This work consists of the removal of material necessary for the construction of foundations for box culverts, box bridges, pipe culverts and headwalls, and other minor structures when authorized by the section covering their construction. It shall also include all necessary pumping, bailing, drainage, cribbing or sheeting, other foundation work, and the backfilling and proper disposal of all excavated material as directed. Unless otherwise specified, excavation for pipe used as sidedrain will not be measured as structure excavation.

206.02--Blank.

206.03--Construction Requirements.

206.03.1--Excavation. No excavation shall be made until the Engineer has cross sectioned and staked out the work. The Contractor shall exercise care to ensure that the adjacent natural ground is not unnecessarily disturbed or the foundation loosened below the bottom of the footing unless additional excavation is required.

When the plans indicate or the Engineer directs removal of material classified in the contract as muck excavation or special excavation, the undercut shall be made and the area backfilled approximately one foot above the flow line of the structure and compacted to the required density before structure excavation is performed.

Foundation areas shall be excavated to the footing elevations and dimensions shown on the plans or as established. The right is reserved to make adjustments in the location or flow line to provide adequate drainage and to make dimension changes in the footings to obtain a satisfactory foundation.

In addition to the requirements of this subsection, excavation for pipe culverts will be performed in accordance with Subsection 603.03.

Material encountered which is unsuitable for a stable foundation shall be excavated and backfilled as provided in Subsection 203.03.

206.03.2--Backfill. All backfilling shall be in accordance with the requirements and provisions of Subsection 203.03.

When the plans indicate or the Engineer orders removal of unsuitable material or other undercut below the normal grade line to provide a satisfactory foundation and further orders a specified depth of select material that may not be available from within the right-of-way or easement areas, the Contractor shall furnish a suitable backfill material such as sand, gravel, or other similar granular materials.

206.04--Method of Measurement. Structure excavation acceptably performed will be measured as set forth herein.

For structures other than pipe culverts, the area to be included in the measurement of structure excavation will be that area bounded by vertical planes one foot outside of the neat lines of the footing.

For pipe culverts, the vertical planes will be one foot each side of the nominal inside diameter of the pipe or less for tile and pipe underdrains if indicated on the plans. The length to be allowed will be one foot beyond each end of the pipe, except when the pipe is joined to another structure for which payment for structure excavation will be made. In this case, the length will be limited to the

point of intersection of the centerline of the pipe with the boundary of structure excavation of joining structures.

The depth allowed will be that actually removed between the natural ground line or the bottom of the graded section, whichever is lower, and the bottom of the footing or the bottom of the trench in the case of pipe. Measurement will not be made for excavation beyond the neat lines described which are made for the convenience or necessity of the Contractor's operation.

The volume of structure excavation allowed for payment will be the summation of the products of the widths, depths and lengths described.

In case the Engineer orders additional excavation for foundation improvement below the depth indicated herein, this excavation within the designated neat lines will be measured as structure excavation.

Unless otherwise specified, selected backfill material shown on the plans or directed by the Engineer to be produced from an area to be excavated under one of the classes of excavation set out in the contract will be measured and paid for under the applicable item of excavation.

Any special ordered (select) material which is produced from excavation identified on the plans as E.S.F.E. will be measured for payment as contractor furnished select material. Select material ordered or authorized by Engineer to provide a satisfactory foundation for structures and conduit will be measured by the cubic yard (FM). Contractor furnished materials such as sand, gravel, granular materials, timber, etc. for backfilling will be paid at the contract unit price of the material used or as extra work in accordance with Subsection 104.03 when the pay item for select material for undercuts is not set up in the contract.

Haul necessary to supply the selected material, other than Contractor-furnished, will be measured as set out in Section 205.

No measurement will be made for water or other liquids removed.

206.05--Basis of Payment. Structure excavation, measured as prescribed above, will be paid for at the contract unit price per cubic yard which price shall be full compensation for the work.

Special materials and/or methods of strengthening the foundation, ordered by the Engineer, will be paid for at the contract unit price for the material used; or, when no unit price is included in the contract, the work will be paid for as Extra Work in accordance with Subsection 104.03.

Payment will be made under:

206-A: Structure Excavation

- per cubic yard

206-B: Select Material for Undercuts, Contractor
Furnished, FM

- per cubic yard

SECTION 209 - GEOTEXTILE STABILIZATION

209.01--Description. This work consists of furnishing and installing geotextile for stabilization of embankments and subgrades as shown in the plans and in conformance with these specifications.

209.02--Materials. The geotextile and incidental materials for this work shall meet the requirements of Subsection 714.13.

209.03--Construction Requirements. A subgrade which is to receive geotextile shall be shaped and compacted to a smooth finish and free of loose material and sharp objects. An embankment site shall be cleared and graded to establish a relatively smooth surface. Trees and stumps are to be cut off at ground line and sawdust or sand placed over these areas to provide a cushion for the geotextile.

The geotextile shall be placed as smooth as possible and free from tension, stress, folds, wrinkles or creases.

Where more than one layer of geotextile is required, all joints of the bottom layer shall be sewn to develop the required geotextile strength perpendicular to the joint. The top layer and single layer installations of geotextile may be overlapped a minimum of two feet at each joint or sewn.

Geotextiles which weigh less than eight ounces per square yard shall be factory or field sewn with a "J" type seam. Heavier weight geotextiles shall be factory sewn with two parallel bag type seams approximately one-fourth inch apart or field sewn with an additional seam zigzagged across the two parallel seams.

Securing pins with washers shall be inserted along a line through the mid-point of any overlap or sewn seam at intervals required by the Engineer to prevent movement of the geotextile until covered.

The subsequent course of material shall be back-dumped in such a manner as to avoid damage to the underlying geotextile. No equipment will be allowed to operate over the geotextile until it is covered with a layer of material of sufficient thickness to protect the geotextile installation. When the underlying soil is very unstable, the two outer one-third portions of an embankment layer shall be placed approximately 25 feet in advance of the center one-third portion to prevent excessive mudwave movements and damage to the geotextile installation.

The Contractor shall provide equipment necessary for placing the geotextile in the position and location as detailed on the plans.

The geotextile shall be protected from contamination and damage during installation and placement of the specified cover material. Contaminated geotextile shall be replaced, and damaged geotextile shall be repaired or replaced as directed at no cost to the Department.

The geotextile shall be covered with a layer of the specified material within 14 calendar days after placement. Geotextile not covered within this time period shall be removed and replaced at the Contractor's expense.

209.04--Method of Measurement. Geotextile stabilization, placed in accordance with these specifications and as directed by the Engineer, will be measured by the square yard of surface area covered. Any over width of material installed and additional material required for laps or sewing will not be measured.

209.05--Basis of Payment. Geotextile stabilization, measured as prescribed above, will be paid for at the contract unit price per square yard, which price shall be full compensation for furnishing and placing the geotextile, pins, lapping, sewing, maintaining the geotextile until covered, and satisfactorily completing the work.

Payment will be made under:

209-A: Geotextile Stabilization, Type ____, AOS __* - per square yard

* When not designated, see 714.13.

SECTION 210 - ROADSIDE DEVELOPMENT

210.01--General Provisions. Where the term "plant establishment" is used, it shall be understood to mean the work and time necessary to provide fully established, healthy vegetation.

Where the term "dormant" is used, it shall be understood to mean the temporary inactive stage of a living plant or seed. When the term "dormant season" is used, it shall be understood to mean a period of time during the year when germination and growth is not expected. It shall be further understood that the limits of the dormant season for each kind of plant shall be determined by the State Roadside Development Manager or authorized representative.

Planting and establishment of vegetation shall be performed at the earliest practicable time consistent with other operations to provide that the maximum

permanent or temporary vegetation is established as quickly as possible.

The Contractor shall schedule work so finishing of all areas requiring vegetation can begin as soon as practicable behind the controlling item of work. Finishing of such areas and the planting shall progress at the same rate as the controlling item of work. The Contractor shall perform plant establishment throughout the life of the contract.

The Contractor, upon written notification by the Engineer of noncompliance with the preceding two paragraphs, will have 48 hours, excluding Sunday, to correct the situation and comply with the specifications.

Upon failure of the Contractor to comply with the written notification, the Engineer will suspend any or all operations in progress as deemed necessary to insure compliance and may deduct from all subsequent estimates an amount equal to 30 percent of the value of all erosion control items completed between the suspension date and subsequent date of compliance. By execution of the contract, the Contractor agrees that such deduction will not be made as a penalty but as agreed reduction in pay for deficient performance by having failed to provide the Department with the maximum possible ground cover as intended under the contract.

On areas which planting, plant establishment, and maintenance have been performed in accordance with the requirements of the contract the requirements for growth and coverage for each kind of plant which is in its dormant season may be waived provided at least one of the kind of the plantings which is not in its dormant season shows satisfactory growth and coverage.

When contract time has expired and all work under the contract has been completed except for the specified growth and coverage of vegetation, liquidated damages will not be charged provided the Engineer's diary documents that the following conditions have been met:

- (a) The Contractor has complied with all instructions of the Engineer with regard to plant establishment, including but not limited to watering, replanting, mowing, and other work specified for plant establishment; and
- (b) The work is deemed to be in a satisfactory state of maintenance, or every reasonable effort is being made to provide satisfactory maintenance.

When any of the conditions for waiver of liquidated damages have not been met, liquidated damages will be charged until the conditions are met or until release of maintenance, whichever occurs first.

Some contracts may require that planting of trees and shrubs or other plantings

be completed by a specified date because of seasonal requirements for their planting. In the event the Contractor fails to complete these plantings within the specified period and must wait until the next season, liquidated damages will be charged after the specified completion date until completion of all plantings as specified and all other work under the contract is completed, except when the Engineer attests that all other work is completed; all the work is in a satisfactory state of maintenance; and the only remaining work which can be performed under the contract is continued plant establishment, only one-seventh of the specified deductions for liquidated damages will be made.

SECTION 211 - TOPSOILING

211.01--Description. This work consists of furnishing if specified, excavating, stockpiling if necessary, transporting, spreading, compacting, and finishing topsoil as specified or directed.

211.02--Materials. The sources and provisions for use of topsoil from local pits located outside the right-of-way shall be as set forth in Section 106. Topsoil shall meet the applicable requirements of Subsection 715.01.

When indicated in the contract, topsoil shall be salvaged from within the construction limits. The topsoil shall be removed only from areas and to depths designated by the Engineer.

211.02.1--Materials Obtained from Right-of-Way. Areas from which topsoil is to be obtained shall be mowed and cleared of foreign materials to the satisfaction of the Engineer.

The approved area shall be excavated neither deeper than the limits of good topsoil nor deeper than necessary to produce sufficient volume to cover the designated areas.

If strata or seams of unsuitable material are encountered during the excavation of topsoil, the material shall be removed from the topsoil. If considered necessary, the area shall be abandoned and satisfactory material produced from other sources.

Topsoil shall either be transported and stockpiled on well drained areas approved by the Engineer, or transported, deposited, and processed directly on designated areas which have been finished, prepared, and approved to receive the topsoil. The Contractor shall spread or dispose of, as directed, all surplus material left in stockpiles without cost to the Department.

211.02.2--Materials Obtained Outside Right-of-Way. Before mining the material, approved areas shall be mowed and raked and cleared of foreign

materials to the satisfaction of the Engineer.

Approval of topsoil pits shall meet the requirements of Subsection 107.23.

It is intended that approved mining operations shall include the mixing or blending of materials that will insure a homogeneous mixture complying with the requirements of the contract.

For pits proposed by the Contractor, the Contractor shall obtain and submit for testing representative samples taken at places designated by and witnessed by the Engineer or the Engineer's representative. If deemed advisable, the Engineer may have Department forces take the samples, and the Contractor shall furnish the assistance required. Based on test results, the Engineer will approve lateral and depth limits of satisfactory materials.

At the Engineer's discretion, samples of the material may be taken at any point prior to spreading on the road. This sampling and testing will be for the purpose of determining whether or not corrective measures should be taken.

Material produced and approved as provided herein, will be accepted as meeting all requirements at the point of final loading for delivery and incorporation into the work.

Approved topsoil, mined as prescribed, shall be transported, deposited and processed directly into its final position on designated areas which have been finished, prepared, and approved unless temporary stockpiling is required or permitted by the Engineer. In case stockpiling is required or permitted, the Contractor shall spread or dispose of, as directed, surplus material left in the stockpile without cost to the Department.

211.03--Construction Requirements.

211.03.1--Conditioning of Areas to be Plated. The conditioning of areas to be plated will depend on the type of existing soil on cut slopes or fill slopes. Conditioning shall be performed so as to secure a bond between the existing soil and the topsoil. Unless otherwise directed, the area to be plated shall be shaped and dressed to the required line, grade, and typical section; disk-harrowed to a depth of at least two inches; and be reasonably free of large clods and stones exceeding three inches in diameter and other foreign materials before topsoil is deposited. On non-tillable slopes, the areas shall be shaped and dressed to the required section, and the Contractor shall cut trenches or furrows approximately six inches deep and approximately 24 to 36 inches apart, as directed by the Engineer dependent upon the steepness of the slope, and on approximate contours. Surplus material from trenching shall be uniformly spread over the area to be plated or otherwise disposed of in a satisfactory manner. In no case shall topsoil be placed on slopes until conditioning of the areas has been

approved.

211.03.2--Application. It is intended that the application of topsoil, the application and incorporation of fertilizer, and other erosion control work will constitute continuous construction, and the Contractor's operation shall be organized accordingly. When the Engineer has determined that the Contractor has made suitable arrangements to carry out these operations as indicated, topsoil shall be deposited on approved areas and spread to the required depth and section. When the required depth of plating material exceeds eight inches, it shall be placed in two or more approximately equal layers of no more than eight inches each.

Objectionable foreign material, large clods that cannot be broken down, and oversize stones shall be removed and the area dressed to present a uniform appearance.

211.03.3--Compaction. After spreading and shaping of the topsoil, compaction shall be performed to the degree that will provide a firm layer having a density of at least what might be expected from one complete coverage of a crawler type tractor track while the material is at a satisfactory moisture content.

211.03.4--Compacted Depth of Topsoil. Topsoil shall be deposited and spread in sufficient quantity so that when compacted it will have the depth specified in the contract.

Determination of depth will be made at random and recorded following compaction of each plated area of approximately 20,000 square feet and more often if determined by the Engineer to be necessary to control the specified depth. Each of the planted areas will be considered a lot. The depth of each lot checked will be the average of at least two and not more than four measurements taken within a square yard area. Except as provided in the following two paragraphs, the average depth of each lot shall not vary from the specified depth by more than one inch or 25 percent of the specified depth, whichever is larger. The average depth of the entire area topsoiled, or the average of the depths of individual lots, shall not vary from the specified depth by more than one inch.

Topsoil measured and paid for on a cubic yard basis may exceed the stated plus tolerances, provided the finished surface is uniform, does not obstruct drainage, and otherwise meets the approval of the Engineer; and further provided that in lieu of the Contractor removing the excess materials at no additional cost to the State, a reduction in pay quantity in the amount of the excess will be made. The excess in each lot will be computed by multiplying the depth in excess of the specified depth plus the tolerance by the area of the lot and the computed excess volume in cubic yards converted to loose vehicular measure by multiplying by 1.25.

Topsoil specified to be measured and paid for on a square yard basis may exceed the stated plus tolerance and remain in place provided the finished surface is uniform, does not obstruct drainage, and otherwise meets the approval of the Engineer. No additional payment will be made for the excessive material placed. The removal of excessive topsoil shall be at the election of the Contractor and at no additional cost to the State.

211.03.5--Topsoil for Plant Holes or Pits. When specified or ordered, topsoil shall be used for backfill material for plant holes or pits. Placement shall be in accordance with the applicable provisions of the specifications for the specified plantings.

211.03.6--Maintenance. The Contractor shall, at no additional cost to the State, preserve, protect, replace, and do other work necessary to maintain the topsoil in a satisfactory and acceptable condition from the time of placing until release of maintenance.

211.04--Method of Measurement. Contractor furnished topsoil will be measured by the cubic yard (LVM), at the point of delivery. For topsoil placed in excess of the specified depth, an adjustment in the measured quantity will be made in accordance with Subsection 211.03.4.

Topsoil specified to be obtained from sources within the right-of-way will be measured by the square yard of surface acceptably plated with topsoil.

Topsoil stripped from construction limits will also be included in the measurement of the applicable excavation item as prescribed in Subsection 203.04.

Unless otherwise specified, measurement for haul of topsoil will not be made.

211.05--Basis of Payment. Topsoil for slope treatment and backfilling of plant holes or pits, measured as prescribed above, will be paid for at the contract unit price per cubic yard or per square yard which shall be full compensation for completing the work.

Payment will be made under:

211-A: Topsoil for Slope Treatment, From Right-of-Way	- per square yard
211-B: Topsoil for Slope Treatment, Contractor Furnished	- per cubic yard
211-C: Topsoil for Plant Holes, Contractor Furnished	- per cubic yard
211-D: Topsoil for Plant Pits, Contractor Furnished	- per cubic yard

SECTION 212 - GROUND PREPARATION

212.01--Description. Ground preparation, light or standard as specified, consists of plowing, loosening, and pulverizing the soil to form suitable beds for erosion control items in accordance with these specifications and in reasonably close conformity with the established lines and grades without appreciable humps or depressions. When performing ground preparation on an area that has been previously planted with temporary grassing, the previously planted grasses shall be disked, tilled, plowed, etc. to assure that the existing temporary grasses are thoroughly mixed into the soil.

212.02--Blank.

212.03--Construction Requirements.

212.03.1--General. Equipment used shall be approved units suitable to perform the work and subject to the requirements of Subsection 108.05.

The Contractor shall take full advantage of weather and soil conditions, and no attempt shall be made to prepare soil when it is wet or in a condition which will not allow the soil to be properly tilled.

Light ground preparation will be required on designated areas where seeding is required to improve the coverage of partially vegetated areas.

Standard ground preparation will be required on areas designated to be solid sodded and areas with no vegetation designated to be seeded.

212.03.2--Light Ground Preparation. Light ground preparation shall consist of scratching the surface with a close-tooth harrow, disk-harrow, or similar equipment within 24 hours after application of required fertilizer. The depth of scratching shall be at least three-quarters inch but not deep enough to damage existing vegetation.

212.03.3--Standard Ground Preparation. Standard ground preparation shall consist of plowing or disk-harrowing and thoroughly pulverizing the areas immediately before the application of erosion control (vegetative) items. Unless otherwise specified, the pulverized and prepared seedbed shall be at least four inches deep and shall be reasonably free of large clods, earth balls, boulders, stumps, roots and other objectionable matter. Incorporation of fertilizer and ground preparation may be performed simultaneously.

Aerating, moistening, or otherwise bringing the soil to a suitable condition for ground preparation shall be considered as incidental to the work and will not be measured for separate payment.

Prepared areas will be inspected by the Engineer, and until approved, subsequent operations shall not be performed.

212.04--Method of Measurement. Ground preparation of the type specified will be measured by the square yard.

212.05--Basis of Payment. Ground preparation will be paid for at the contract unit price per square yard which shall be full compensation for completing the work.

Payment will be made under:

- 212-A: Light Ground Preparation - per square yard
- 212-B: Standard Ground Preparation - per square yard

SECTION 213 - FERTILIZING

213.01--Description. This work consists of furnishing, transporting, spreading, and incorporating fertilizers of the types and in the amounts designated.

213.02--Materials. Fertilizers for purposes of these specifications shall be understood to include standard manufactured products consisting of single or combination ingredients and agricultural limestone.

All fertilizer shall comply with the State Fertilizer Laws and the requirements of these specifications.

Fertilizers shall meet the requirements of Subsection 715.02. All fertilizer shall be handled so as to insure proper protection at all times. All fertilizers, except agricultural limestone, shall be furnished in standard bags. When approved by the Engineer, bulk fertilizer may be used. The Contractor shall provide means suitable to the Engineer for applying bulk fertilizer. The Engineer shall weigh shipments at random for verification of bulk fertilizer quantities.

213.03--Construction Requirements. The Contractor shall furnish all equipment necessary to properly handle, store, uniformly spread, and incorporate the specified application of fertilizer.

The type and rate of application of each fertilizer to be applied will be indicated on the plans or determined by soil tests. The amounts and types of fertilizers shall be applied uniformly on the areas to be planted or seeded and uniformly incorporated into the soil.

Fertilizers shall be applied on individual areas of not more than three acres. The

Engineer will determine the actual amounts of fertilizers to be applied on each area. For agricultural limestone, a tolerance of 15 percent will be permitted without correction. For all other types of fertilizer, a tolerance of 10 percent will be permitted without correction. Areas deficient in application by more than these tolerances shall be corrected by re-application in a manner approved by the Engineer. For areas on which fertilizer has been placed in excess of the tolerance permitted the amounts in excess of the tolerances will be deducted from the measured quantities.

All fertilizer shall be incorporated within 24 hours following spreading unless otherwise directed. Incorporation of fertilizer into soils other than topsoil shall include standard ground preparation in accordance with Subsection 212.03. When topsoil is used, the fertilizer shall be incorporated into the top three inches.

Unless otherwise specified, when fertilizer is to be applied to existing vegetation, incorporation shall be accomplished immediately after the application by mowing the vegetation to a height of approximately four inches.

213.04--Method of Measurement. Fertilizer of the type specified, applied as ordered in accepted work, will be measured by the ton. Fertilizer not applied and incorporated in accordance with these specifications and fertilizer applied in unacceptable work will be deducted from measured quantities.

The measured quantity of fertilizer failing to meet the guaranteed analysis, as set out in Subsection 715.02, will be adjusted in proportion to the guaranteed analysis and the actual analysis.

Mowing required during fertilization of existing vegetation will be measured and paid for under pay item 223-A, Mowing.

213.05--Basis of Payment. Agricultural limestone will be paid for at the contract unit price per ton. Types of fertilizer, combination and manufactured, specified to be placed prior to planting will be paid for at the contract unit price per ton. All fertilizers for additional applications based on soil tests will be paid for on the basis of the contract unit price per ton for super-phosphate (0-20-0) plus or minus the applicable amount from the following schedule. Prices paid shall be full compensation for furnishing fertilizer and completing the work.

Type of Fertilizer	Superphosphate Contract Unit Price
15-10-10	plus \$25.00 per ton
6-8-8	minus \$10.00 per ton
18-46-0	plus \$130.00 per ton
12-24-12	plus \$60.00 per ton
8-24-24	plus \$60.00 per ton
0-20-20	plus \$20.00 per ton
13-13-13	plus \$30.00 per ton
Muriate of Potash (60%)	plus \$0.00 per ton
Ammonium Nitrate	plus \$40.00 per ton
Urea	plus \$70.00 per ton
Ureaform (38-0-0)	plus \$225.00 per ton
Ureaform (10-10-10)	plus \$90.00 per ton

Payment will be made under:

213-A: Agricultural Limestone	- per ton
213-B: Combination Fertilizer, <u>Type</u>	- per ton
213-C: Superphosphate	- per ton
213-D: Ammonium Nitrate	- per ton

SECTION 214 - SEEDING

214.01--Description. This work consists of furnishing the specified seeds and inoculants for legume seed, treating the legume seeds, and planting the seeds in a prepared and approved seedbed; covering the seeds and compacting the seedbed; and providing plant establishment on all areas seeded. All the work shall be in accordance with the plans and these specifications.

214.02--Materials. Seeds shall meet the requirements of Subsection 715.03, subject to the provisions of this subsection. The Contractor shall acquire seed from supplier registered with the Mississippi Department of Agriculture and Commerce.

Except for the germination test as referenced in Subsection 715.03, bags of seeds properly labeled or tagged according to law and indicating characteristics meeting or exceeding the requirements of these specifications will be acceptable for planting.

The Contractor shall provide adequate dry and otherwise protected and approved

storage facilities for seeds, and shall furnish access to the storage for sampling and for the Engineer to inventory stored seed and inspect the suitability of the storage facilities.

Seeds that have been sampled and tested by the Mississippi Department of Agriculture and Commerce shall be acceptable for planting provided (1) that prior to planting, the Contractor furnishes the Engineer two copies of test reports from the Mississippi Department of Agriculture and Commerce indicating that the seeds meet the germination requirements, (2) not more than nine months have elapsed, exclusive of the calendar month in which the test was completed, between the germination test data and the time of planting, and (3) the seeds were properly stored and handled.

Seeds that have not been sampled and tested by the Mississippi Department of Agriculture and Commerce and test reports furnished prior to planting shall be sampled and tested for germination requirements by the Department.

The Contractor may use pre-tested, or post-tested seeds under the conditions stated herein. For seeds to be pre-tested, approximately 35 days from the date of sampling will be required to obtain the test results.

When pre-tested seeds are planted, a minus tolerance of five percent of the specified germination percentage will be allowed without adjustment. Seeds failing to comply by more than five percent may be planted, provided the rate of seeding is increased by 100 percent of the deficiency with the same or approved seeds, without additional compensation.

The Engineer may permit the Contractor to plant post-tested seeds, provided the seeds are properly tagged and have indicated characteristics meeting the requirements of these specifications without applying tolerances. If the seeds are planted, the Contractor shall assume full responsibility for the specified percent germination of the seeds upon subsequent tests. Acceptance or re-sowing will be based on the results of the subsequent tests. A minus tolerance of five percent of the specified germination percentage will be allowed without adjustment. If the tests indicate a deficiency in excess of five percent; (1) the deficiency shall be corrected by immediately re-sowing an amount of seeds equal to 200 percent of the deficiency with the same or approved seeds without additional compensation, or (2) should it be determined, by inspection, that a sufficient number of seeds have germinated to produce satisfactory growth and coverage, the Engineer will deduct from measured quantities an amount of seeds equal to 100 percent of the deficiency. Otherwise, the area seeded will not be considered in reasonably close conformity with the requirements of these specifications.

214.03--Construction Requirements.

214.03.1--General. Prior to planting the seeds, topsoil when specified, ground

preparation, and fertilizing shall have been satisfactorily performed and the area approved by the Engineer.

Seeding may be required for temporary protection or for establishment of permanent ground cover. The plans will indicate temporary seeding.

The rates of application, kinds, and the planting dates of seeds shall be as set out in the vegetation schedule on the plans. The Engineer will determine the actual quantity of seeds to be applied on individual areas of not more than three acres.

Legume seeds shall be treated in accordance with Subsection 715.03.4 immediately before sowing. Seeds shall be uniformly sown over the entire area with approved mechanical seeders. Seeds of different sizes may necessitate separate sowing. Should legume seeds become dry, they shall be re-inoculated.

Seeding shall not be done during windy weather or when the ground is frozen, extremely wet, or in a condition which will not allow the soil to be properly tilled

All seeds shall be covered lightly with soil by raking, rolling, or other approved methods, and the area compacted with a cultipacker.

When specified, mulching shall be performed in accordance with the requirements of Section 215 as soon as practicable but no later than 24 hours after seeding unless weather conditions are such that mulch cannot be placed.

214.03.2--Plant Establishment. The Contractor shall provide plant establishment on all areas seeded until release of maintenance.

Plant establishment shall be provided for a minimum period of 45 calendar days after completion of seeding. In the event satisfactory growth and coverage has not been attained by the end of the 45-day period, plant establishment shall be continued until the specified growth and coverage is provided for at least one kind of plant as referenced in Section 210. The Contractor shall perform plant establishment on all areas of temporary seeding until the Engineer determines that the temporary seeding has served its purpose.

Plant establishment shall consist of preserving, protecting, watering, reseeding, mowing, and other work necessary to keep the seeded areas in satisfactory condition.

Unless otherwise permitted, areas requiring reseeding shall be prepared and seeded and all other work performed in accordance with the requirements of the contract as if the reseeding was the initial seeding. The types and application rates of fertilizer will be determined by soil tests or otherwise established.

214.03.3--Growth and Coverage. It shall be the Contractor's responsibility to

provide satisfactory growth and coverage of grasses, legumes, or combination produced from the specified seeding.

Growth and coverage on seeded areas will be considered to be in reasonably close conformity with the intent of the contract when the type of vegetation specified, exclusive of that from seeds not expected to have germinated and shows growth at that time, has reached a point of maturity where stems or runners overlap adjacent similar growth in each direction over the entire area.

214.04--Method of Measurement. Seeding will be measured by the acre, or by the pound, as indicated in the contract.

Except as provided under Subsection 107.17, no measurement for payment will be made for any materials or work required under Subsections 214.03.2 and 214.03.3.

Watering for seeding will not be measured for separate payment.

214.05--Basis of Payment. Seeding, measured as prescribed above, will be paid for at the contract unit price per acre or per pound, as indicated, which price shall be full compensation for completing the work.

Payment will be made under:

214-A: Seeding, Kind - per acre or pound

214-B: Seeding, Seed Mixture, Designation - per acre

SECTION 215 - MULCHING

215.01--Description. This work consists of furnishing, transporting, placing, and anchoring vegetative mulch on slopes, shoulders, medians, and other designated areas.

215.02--Materials. The vegetative materials for mulch shall meet the requirements of Subsection 715.05.

It is intended that Type I Vegetative Materials shall be used when available. When it is determined by the Engineer that Type I Vegetative Material is not reasonably available, Type II Vegetative Material will be permitted as provided in Subsection 715.05, with the concurrence of the State Roadside Development Manager.

Bituminous material for mulch shall be Emulsified Asphalt, Grade SS-1, meeting the requirement of Subsection 702.07. Subject to satisfactory results being

obtained, this material will be accepted on a certification basis in accordance with Subsection 106.04.

215.03--Construction Requirements.

215.03.1--Equipment. Mulching equipment shall be capable of maintaining a constant air stream which will blow or eject controlled quantities of mulch in a uniform pattern. If asphalt is used, a jet or spray nozzle for applying uniform, controlled amounts of asphalt to the vegetative material as it is ejected shall be located at or near the discharge spout.

Mulch stabilizers shall consist of dull blades or disks without camber and approximately 20 inches in diameter. The disks shall be notched, shall be spaced at approximately 8-inch intervals, and shall be equipped with scrapers. The stabilizer shall weigh approximately 1000 to 1200 pounds, shall have a working width of no more than eight feet, and shall be equipped with a ballast compartment, so that when directed weight can be increased.

215.03.2--Placement of Vegetative Mulch. Mulching shall be placed uniformly on designated areas within 24 hours following seeding unless weather conditions are such that mulching cannot be performed. Placement shall begin on the windward side of areas and from tops of slopes. In its final position the mulch shall be loose enough to allow air to circulate but compact enough to partially shade the ground and reduce erosion.

The baled material shall be loosened and broken thoroughly before it is fed into the machine to avoid placement of unbroken clumps.

215.03.3--Rates of Application and Anchoring Mulch. The Engineer will designate the rate of application of vegetative mulch within the limits of one to two tons per acre. The mulch may be anchored by either the use of a mulch stabilizer or by tacking with bituminous material. If a mulch stabilizer is used, the mulch shall be punched into the soil for a minimum depth of one inch. If bituminous material is used, the rate of application shall be 150 gallons per acre.

Where steep slopes or other conditions are such that anchoring cannot be performed satisfactory with a mulch stabilizer, the Engineer will require the bituminous material be applied at the time or immediately following the mulch placement.

When mulch stabilizers are used, anchoring the mulch shall be performed along the contour of the ground surface.

As the work progresses, the Engineer will determine the actual rate of application of the vegetative mulch and the bituminous material, if used, on each area not to exceed three acres. For vegetative mulch, a tolerance of 15 percent will be

permitted without correction. For bituminous material, if used, a tolerance of 10 percent will be permitted without correction. Areas deficient in application by more than these amounts shall be corrected by reapplication in a manner approved by the Engineer. For areas on which vegetative material has been placed in excess of the tolerance permitted, that portion of the material placed in excess of the tolerance allowed will be deducted from the measured quantities. In the event an excess of vegetative material has been placed in a quantity deemed by the Engineer to be undesirable, the Contractor shall remove and replace all material placed on that area at no additional cost to the State.

215.03.4--Protection and Maintenance. The Contractor shall maintain and protect mulched areas until release of maintenance of the project. The Contractor shall take every precaution to prevent unnecessary foot and vehicular traffic and shall repair and restore immediately any displacement of mulch without extra compensation.

At appropriate times determined by the Engineer, the Contractor shall mow or otherwise remove or destroy all undesirable growth on all areas mulched to prevent competition with the desired plants and to prevent reseeding of undesirable growth. All mowing shall be a part of protection and maintenance.

215.04--Method of Measurement. Accepted quantities of vegetative material for mulch will be measured by the ton.

The weight for measurement will be the product of the number of bales acceptably placed and the average weight per bale as determined on approved scales provided by the Contractor.

Anchoring of vegetative mulch, whether by use of a mulch stabilizer or by application of bituminous material, will not be measured for separate payment. The cost of anchoring shall be absorbed in the prices bid for other items of work.

215.05--Basis of Payment. Vegetative material for mulch will be paid for at the contract unit price per ton and shall be full compensation for completing the work.

Payment will be made under:

215-A: Vegetative Materials for Mulch - per ton

SECTION 216 - SOLID SODDING

216.01--Description. This work consists of furnishing, transporting, and planting approved grass sod in accordance with the plans and these specifications. This work shall also include plant establishment as specified and

required to assure satisfactory growth of the solid sod.

216.02--Materials. Unless otherwise specified, solid sod shall be common bermuda, bahia, or other approved sod species and shall be live, fresh, growing grass, unless in the dormant season, with at least one and one-half inches of soil adhering firmly to the roots when placed. The sod shall be reasonably free from obnoxious weeds or other grasses, and shall not contain any matter deleterious to its growth, or which might affect its subsistence or hardiness when transplanted. The sod shall be in blocks at least eight inches by eight inches and reasonably free from ragged edges. All sod shall be harvested from areas where the topsoil is fertile, and the areas shall have been grazed or mowed sufficiently to form a dense turf. The area from which the solid sod is to be harvested shall be closely mowed, and raked if deemed necessary to remove excessive top growth and debris.

When a kind of solid sod is specified, the material shall be nursery grown, healthy, free from damage, and free from noxious weeds and grasses. The nursery grown sod shall be in blocks at least eight inches by eight inches by one inch and reasonably free of ragged edges.

All solid sod materials shall be approved by the Engineer prior to transplanting.

216.03--Construction Requirements.

216.03.1--Procuring and Handling Sod. Approved sod cutters shall be used for cutting the sod into strips or blocks. Care shall be exercised at all times to retain the native soil on the roots of the sod during the process of excavating, hauling, and planting.

The sod shall be transplanted within 24 hours after arriving on the project, unless it is stacked in a manner satisfactory to the Engineer. All sod in stacks shall be kept moist and protected from exposure to the wind and sun and from freezing.

In no event shall more than three days elapse between the cutting and planting of the sod without approval of the Engineer.

216.03.2--Grading of the Area to Receive Solid Sodding. Prior to ground preparation for solid sodding, all excavating, shaping, and dressing shall have been completed in such a manner that the foundation for the sod has the proper cross section, line, and grade and so that the sod after placement will be flush with or slightly below the adjacent final ground line.

216.03.3--Ground Preparation and Fertilizing. After the area has been graded as required, the specified types and quantities of fertilizers shall be uniformly spread and then incorporated by standard ground preparation in accordance with Section 212. The prepared area shall be at an approved moisture content and

shall present a smooth, uniform surface with reasonably close conformity to the specified line, grade, and cross section. After approval by the Engineer of the prepared and fertilized area, sodding shall follow immediately.

216.03.4--Planting Sod. The sod shall be placed on the prepared surface with edges in close contact and starting at the lowest point and working upward. Cracks between blocks of sod shall be filled with small pieces of fresh sod, and all cracks too small for sod shall be filled by a light dressing of approved soil. The entire sodded area shall then be compacted and watered to the satisfaction of the Engineer. Light rollers, hand tamps, or other approved equipment shall be used for compacting.

On areas which the Engineer deems that the sodding might slide due to the height and slope of the surface or nature of the soil, the sod shall be "pegged" with wooden pegs driven through the sod blocks into firm earth. Pegs shall be at intervals deemed suitable to hold the sod in place.

216.03.5--Limitations. Solid sodding shall be performed only when weather and soil conditions are deemed by the Engineer to be suitable for proper placement.

216.03.6--Plant Establishment. Plant establishment shall consist of preserving, protecting, replacing, watering, mowing, and other work necessary to keep the sod in a satisfactory condition at all times until final acceptance.

A satisfactory growth of solid sodding shall be understood to mean a healthy, living, and growing grass turf, unless in the dormant season, which has been planted on an approved prepared foundation and has been maintained in accordance with the requirements of these specifications.

216.04--Method of Measurement. Solid sodding will be measured by the square yard.

If solid sodding is required by the contract, or ordered by the Engineer, on a section graded under a previous contract, required excavation, exclusive of trenching out and fine grading, will be measured under the appropriate excavation item of the contract, or as extra work.

Fertilizer ordered and acceptably used will be measured and paid for as prescribed in Subsection 213.04.

Standard ground preparation will be measured and paid for as prescribed in Subsection 212.04.

Water ordered will be measured and paid for as prescribed in Subsection 219.04.

216.05--Basis of Payment. Solid sodding will be paid for at the contract unit

price per square yard and shall be full compensation for completing the work.

Payment will be made under:

216-A: Solid Sodding - per square yard

216-B: Solid Sodding, Kind - per square yard

SECTION 217 - DITCH LINER

217.01--Description. This work consists of furnishing, placing, and maintaining a ditch liner of jute mesh, excelsior blanket, erosion control blanket or erosion control fabric on seeded, or other designated areas in accordance with the plans and specifications. Asphalt-coated fiber glass roving meeting the requirements of Section 218 may be substituted for ditch liner. Any substituted fiber glass roving will be measured by the square yard and paid at the contract bid price for ditch liner.

217.02--Materials. The type of material used for the ditch liner shall be at the option of the Contractor unless otherwise specified. Jute mesh, excelsior blanket, erosion control blanket and erosion control fabric shall meet the requirements of Subsection 715.09.

217.03--Construction Requirements.

217.03.1--General. The areas to be covered shall be prepared, fertilized, vegetated and left in a smooth uniform condition, free of stones, lumps, roots or other material which will prevent the ditch liner from being in contact with the underlying soil. Immediately following the planting operation, the ditch liner shall be installed by unrolling it in the direction of water flow and draping it loosely, without folds or stretching, so that continuous ground contact is maintained. The mulch material shall be omitted from areas receiving the ditch liner.

When two or more strips are required to cover a ditch area, the longitudinal laps shall be a minimum of four inches with the upgrade width on top. Transverse laps shall be a minimum of 12 inches with the upgrade section on top.

The end of the material at the beginning and ending of each area to be covered shall be folded and placed in a vertical anchor trench at least six inches deep, and stapled in the trench on six-inch centers, backfilled, and tamped. When directed, edges subject to scour shall be buried similarly. On the upgrade end, reinforce with a row of staples on six-inch centers about one foot below the anchor trench. All transverse laps shall be stapled on 12-inch centers and longitudinal laps on 36-inch centers. Each strip of material shall be stapled in three rows at the edges

and center with staples spaced not more than three feet longitudinally. The staples shall anchor the fabric netting. Check slots, a row of staples on 12-inch centers perpendicular to the flow line, shall be installed at 50-foot intervals.

On the downstream end of a ditch liner adjoining a structure, the anchor trench shall be omitted and the material folded under six inches and butted tightly against the structure and one row of staples installed on six-inch centers. An edge adjacent to a paved ditch shall be butted tightly against the paved ditch and a row of staples installed on 12-inch centers. All staples shall be driven flush with the soil surfaces.

Ditch liner materials used on areas other than ditches may be placed either horizontally or vertically. Adjacent strips of excelsior blanket material shall be butted tightly together and secured with a common row of staples rather than lapped as set forth for ditch installation. The staples shall be spaced on three-foot centers or less as determined by the Engineer based on field conditions. The excelsior blanket and erosion control blanket shall be placed with the fabric net facing up.

217.03.2--Protection and Maintenance. The Contractor shall maintain and protect the ditch liner until release of maintenance or until the Engineer has determined that the liner has served its useful life, whichever occurs first. Maintenance shall consist of repairs necessitated by erosion, wind, fire, or other cause.

217.04--Method of Measurement. Ditch liner will be measured by the square yard of surface area covered. Any over width of material installed wider than ordered, laps and anchor slots will not be measured for payment.

217.05--Basis of Payment. Ditch liner, measured as prescribed above, will be paid for at the contract unit price per square yard and shall be full compensation for completing the work.

Payment will be made under:

217-A: Ditch Liner - per square yard

SECTION 218 - BITUMINOUS TREATED ROVING

218.01--Description. This work consists of furnishing and installing a layer of bituminous treated roving to stabilize newly planted soil areas in ditches and on slopes in accordance with these specifications and at locations shown on the plans or as directed by the Engineer.

218.02--Materials.

218.02.1--General. The type of roving material, fiberglass or polypropylene, shall be at the option of the Contractor unless otherwise specified and shall meet the applicable requirements of Subsection 715.09.6.

The glass fibers or fibrillated polypropylene yarn shall be wound onto cylindrical packages so that the roving can be continuously fed through an ejector driven by compressed air and expanded into a mat. The fibers or yarn shall be lightly bound together in a ribbon form, without the use of clay, starch, or other deleterious substances. The material shall not contain petroleum solvents, or other agents known to be toxic to plant or animal life.

The roving material shall not be exposed to moisture prior to placement.

218.02.2--Bituminous Material. The bituminous material used for securing the roving to the existing soil shall be Emulsified Asphalt, Grade SS-1, meeting the requirements of Subsection 702.07.

218.03--Construction Requirements.

218.03.1--Equipment. An air compressor shall be used in conjunction with applying the glass fiber or polypropylene yarn. The compressor shall be capable of supplying 40 cubic feet of air per minute at a pressure of 80 to 100 pounds per square. An air gun specifically designed for spraying glass fibers or polypropylene yarn, sufficient 3/8-inch rubber hose for application, and at least one container shall be furnished for applying the material. Three spools or packages may be run simultaneously from a 125-cubic foot compressor. Equipment which cuts or breaks the roving will not be permitted. Equipment for applying the asphalt shall be capable of applying the material in a uniform spray at the rate specified.

218.03.2--General. The bituminous treated roving shall be applied over designated areas within 24 hours following the planting or seeding operations. The designated areas shall be free of all objects including the vegetative material for mulch that would keep the roving material from being in direct contact with soil throughout the entire area to be treated.

The upgrade and downgrade ends of the bituminous treated roving shall be buried in a six-inch minimum vertical slot and the soil tamped firmly against it.

The bituminous treated roving shall be applied uniformly over the planted areas at one of the following rate with a $\pm 20\%$ tolerance:

- a) Bituminous Treated Fiberglass Roving 0.50 pounds per square yard
- b) Bituminous Treated Polypropylene Roving 0.20 pounds per square yard

The rate of distribution will be determined from the number of spools or packages of roving used on each area and the average weight of the spools or packages. A sample of at least five spools or packages designated at random by the Engineer will be taken and weighed and the average weight to the nearest pound per spool or package will be used for the truckload from which the sample was taken.

Immediately following the spreading of roving, the asphaltic material shall be applied uniformly over the roving at the rate of 0.50 gallons per square yard with a $\pm 20\%$ tolerance.

The Contractor shall be required to apply additional asphaltic material, if needed, to penetrate through the roving in sufficient quantity to secure the roving to the soil.

218.03.3--Protection and Maintenance. The Contractor shall maintain and protect the bituminous treated roving mat until release of maintenance or until the Engineer has determined that the mat has served its useful life, whichever occurs first. Maintenance shall consist of repairs made necessary by erosion, wind, fire, or any other cause.

218.04--Method of Measurement. Bituminous treated roving will be measured by the square yard of surface area covered.

The additional materials required for terminal slots and materials placed outside the limits of the designated area(s) requiring treatment will not be measured for payment.

218.05--Basis of Payment. Bituminous treated roving, measured as prescribed above, will be paid for at the contract unit price per square yard, which shall be full compensation for completing the work.

Payment will be under:

218-A: Bituminous Treated Roving - per square yard

SECTION 219 - WATERING

219.01--Description. This work consists of furnishing, transporting, and applying water as specified during the planting operations and establishment of roadside vegetation excluding seeding. It shall be understood that watering will be measured and paid for only when ordered by the Engineer and used for items specified and when a pay item is included in the contract.

219.02--Materials. Water shall be as specified in Subsection 714.01.5.

219.03--Construction Requirements. Loading operations on the roadway resulting in water-logging or excessively wet basement soils, design soils, or base courses will not be permitted.

Water shall be applied in the manner and quantities, at the times, and for the purposes set forth in the contract or directed.

The quantities of watering shown in the contract are estimated for bidding purposes only and these quantities may be varied dependent upon need or may be omitted entirely with no adjustment in unit contract price.

The equipment furnished and used for this work shall be approved as adequate and suitable for the purpose used.

219.04--Method of Measurement. The quantity of water furnished and applied as directed or permitted will be measured to the nearest one thousand gallons (M gallons) by approved meters, measured tanks, or calibrated tanks.

In accordance with the intent of Subsection 109.01, the capacity of tanks may be made by weight and converted to one thousand gallons (M gallons) by dividing the weight in pounds by 8,330.

Water used by the Contractor in items of work not specifically authorized or directed by the Engineer or water wasted, improperly applied, or otherwise used for unauthorized purposes will not be measured for payment.

219.05--Basis of Payment. Water ordered or authorized, delivered, and applied will be paid for at the fixed contract unit price per one thousand gallons (M gallons) as pre-entered in the proposal and shall be full compensation for satisfactorily completing the work.

No change in payment will be made because of differential cost of watering from the fixed contract unit price. It is fully understood and agreed that any differential cost will be included in the price bid for other roadside development items.

Payment will be made under:

219-A: Watering - per M gallons

SECTION 220 - INSECT PEST CONTROL

220.01--Description. This work consists of furnishing and applying approved insecticides to control armyworms and other destructive insects that damage or destroy planted vegetation.

It shall be the Contractor's responsibility to continually observe the planted areas for insect damage, especially during the late summer and early fall. The Contractor shall, upon observing destructive insects, report it to the Engineer. If the Engineer or the Engineer's representative observes insect damage, the Contractor will be notified.

220.02--Materials. The Contractor shall select and furnish an effective insecticide produced by a reputable manufacturer in accordance with all Federal and State Laws and Regulations, and it shall meet the approval of the Engineer. The material shall be furnished in properly labeled containers. The Contractor shall be responsible for handling, storing and applying the material in accordance with the information shown on the label and complying with all Federal and State Laws and Regulations regarding its application and use. The Department will not be liable for violations in applying the material or damage caused by its use.

220.03--Construction Requirements.

220.03.1--General. The Engineer will determine the areas to be treated, and the Contractor shall immediately treat these areas unless weather conditions are unfavorable for proper treatment. The Contractor shall apply the approved insecticide at the rate and in the manner according to the requirements shown on the label of the container for the destructive pest being controlled. The equipment used in applying the material shall produce uniform coverage.

The Engineer will determine if satisfactory pest control was obtained on the treated areas. The Contractor shall reapply insecticides to areas where control is unsatisfactory at no additional cost to the State.

When the Engineer determines that pest control efforts were timely and correctly applied, the Contractor will be paid for any required re-grassing. If the Engineer determines that pest control efforts were unsatisfactory, the Contractor will re-grassing the area at no additional cost to the State.

220.03.2--Safeguards. In addition to the requirements specified in Subsection 220.02, safeguards in applying insecticides are the responsibility of the Contractor, and the Contractor shall be responsible for damage to the wildlife and human welfare.

The following are minimum basic safeguards to be observed:

- (a) All insecticides shall be applied by approved ground equipment or approved aircraft mounted spray equipment. Aerial application shall be approved in writing by the Engineer.
- (b) Personnel must be qualified to engage in this work.

- (c) Personnel handling the insecticide and equipment operators must wear the recommended protective apparel.
- (d) Avoid drift of insecticide on adjacent property.
- (e) Do not contaminate streams, ponds or lakes.
- (f) Some insecticides are highly toxic to bees. When application is to be near bee hives, provide a days advance notice to the beekeeper.
- (g) Normally, insecticide application will be restricted to roadside areas which are under construction and not open to the public. Precautions for the protection of the public must be taken when treatment is ordered for rest areas, parks, etc.; namely, by keeping pedestrians off the area until the insecticide is washed off the turf area or the insecticide deteriorates and is not harmful.

Application methods and rates shall be in accordance with the instructions shown on the label of the insecticide container.

220.03.3--Contract Quantities. The quantity for insect pest control is estimated for bidding purposes only and this quantity may be varied dependent upon actual need or omitted entirely.

220.04--Method of Measurement. Insect pest control of the area properly treated and accepted will be measured by the acre. The area shall be computed from measurements taken parallel to the surface of the treated area.

220.05--Basis of Payment. Insect pest control, measured as provided above, will be paid for at the fixed contract unit price per acre as pre-entered in the proposal and shall be full compensation for completing the work.

No change in payment will be made because of differential costs from the fixed contract unit price. It is fully understood and agreed that any differential cost will be included in the prices bid for other roadside development items.

Payment will be made under:

220-A: Insect Pest Control - per acre

SECTION 221 - PAVED DITCHES

221.01--Description. This work consists of constructing paved ditches of portland cement concrete or hot bituminous plant mix, as specified in the contract and constructed in accordance with the provisions and requirements of these

specifications, and in reasonably close conformity with the lines, grades, typical cross sections, and locations shown on the plans or established.

221.02--Materials.

221.02.1--Portland Cement Concrete Paved Ditches. The materials used in the construction of portland cement concrete paved ditches shall conform to the applicable provisions and requirements of Section 804.

221.02.2--Bituminous Paved Ditches. The materials used in the construction of bituminous paved ditches shall conform to the applicable requirements for hot bituminous mixtures as set out in Section 401.

221.02.3--Reinforcement. Reinforcement shall meet the requirements of Subsection 711.02.

221.03--Construction Requirements.

221.03.1--General. The foundation for paved ditches shall be formed by excavating to the required depth and dimensions below the prepared finished surface grade of the paved ditch.

The foundation shall be thoroughly compacted by hand tamping or other approved method. Soft, spongy, or other unsuitable material shall be removed as directed and replaced with suitable material thoroughly compacted in six inch layers.

The forms used in this construction may be wood or metal; shall have a depth equal to the prescribed edge thickness of the paved ditch; and shall be of sufficient strength to withstand the weight of the concrete or bituminous mixture and the pressure incidental to vibration or compaction without bulging or displacement. Forms shall be securely staked and braced.

Reinforcement, if specified, shall be placed in a manner that will insure its proper position in the paved ditch section after all concrete is placed.

221.03.2--Portland Cement Concrete Paved Ditches. Unless otherwise specified on the plans, the portland cement concrete paved ditches shall be constructed of Class "C" concrete, mixed and placed in accordance with the applicable requirements of Section 804, and cured in accordance with the requirements of Subsection 501.03.20 or by other approved methods. The limitations of mixing and placing shall conform to the requirements of Subsection 501.03.12.

A template mounted on the side forms shall be used in striking off and finishing the surface of the concrete to the required shape and dimensions. The entire unit

shall be constructed monolithic with smooth fillets or curves at all angles or breaks in flow lines. Concrete shall be placed beginning at the bottom of the slope and progressing upward. The finished exposed surface of portland cement concrete paved ditches shall be given a Class 6, Floated Surface Finish in conformity with the requirements of Subsection 804.03.19.

Expansion joints shall be constructed at the locations indicated on the plans or directed, and shall be of the specified materials and dimensions.

221.03.3--Bituminous Paved Ditches. Bituminous paved ditches shall be constructed using a hot mix asphalt (HMA) mixture. The mixture shall meet job-mix requirements for the particular mixture used except the percent of asphalt cement designated in the job-mix formula may be increased by the Engineer by no more than two percent.

The mixture shall be spread, raked, finished, and compacted by hand tools or other satisfactory methods while at the proper temperature to form a smooth, stable, and impermeable lining.

221.03.4--Backfilling and Cleaning Up. After the concrete has set sufficiently or after the hot mix asphalt has been compacted to the required shape and dimensions, the forms shall be removed and the spaces around the paved ditch shall be backfilled with approved material and thoroughly compacted without damage to the paved ditch. The adjacent ditch slopes shall be neatly trimmed to the required section, and all surplus material shall be disposed of as directed.

221.04--Method of Measurement. Portland cement concrete paved ditch will be measured in cubic yards.

Bituminous paved ditch will be measured by the ton of HMA material actually placed. No measurement for separate payment will be made for any additional asphalt cement required in the mix.

Excavation required for trenching and fine grading will not be measured for separate payment. Other required excavation will be measured for payment under the applicable excavation items.

221.05--Basis of Payment. Portland cement concrete paved ditch will be paid for at the contract unit price per cubic yard and shall be full compensation for completing the work.

Bituminous paved ditches will be paid for at the contract unit price per ton and shall be full compensation for completing the work.

Payment will be made under:

221-A: Portland Cement Concrete Paved Ditch

- per cubic yard

221-B: Bituminous Paved Ditch

- per ton

SECTION 223 -- MOWING

223.01--Description. When the contract includes a pay item for mowing and when the Engineer determines that mowing is necessary, the Contractor shall perform litter removal and mowing of noxious vegetation or excess growth as directed by the Engineer in accordance with the provisions contained herein. Mowing shall also be required, when necessary, for the safe and convenient passage of traffic, as required in Subsection 104.04, Maintenance of Traffic. The importance of public safety and workplace safety can not be overemphasized. Special attention is made to Subsections 107.06, 107.07 and 107.10 of the Standard Specifications.

Prior to mowing, the Contractor shall pick up and properly dispose of all trash and debris within the area to be mowed and along any adjacent roadway shoulders. Trash and debris picked up and piled or bagged on the roadside must be removed from the right-of-way by the close of the work day. Piles or bags will not be allowed to remain on the roadside overnight. All trash and debris is defined as all trash, debris, litter, junk, rubbish, paper, cardboard, glass, cans, styrofoam cups, discarded items, garbage, old tires, treads, etc. The Contractor will not be required to pick up such items as cigarette butts, tiny chips of grass or other small items not readily visible to the traveling public.

The Engineer will advise the Contractor when mowing will be needed. The Engineer has the right to eliminate completely or partially any mowing on the project. The Engineer will advise the Contractor of the area to be mowed and the time to begin the mowing operations. The Engineer may delay mowing of lespedezas or crimson clover until after these plants have gone to seed. Mowing may be delayed to retain and promote desirable wildflower growth.

Mowing will be to a height of not more than six (6) inches and will include trimming adjacent to culvert ends, guard rail, sign posts or other appurtenances. Trimming adjacent to objects inaccessible by mower shall be performed by hand mowers, weed-eaters, sling blades, or any acceptable means necessary to complete the work. Care shall be taken not to damage trees, plants, shrubs, delineators or other fixtures which are part of the facility. Any damages by the Contractor's operations to signs, delineators, other traffic control devices or other appurtenances shall be corrected immediately at no additional cost to the State.

The quantity of mowing will be affected by actual conditions which occur during construction and may be eliminated entirely at the direction of the Engineer.

223.02--Blank.**223.03--Construction Requirements.**

223.03.1--General. The Contractor shall perform the work throughout the entire project on those areas directed by the Engineer. The Contractor shall take full advantage of weather and soil conditions, and no attempt shall be made to mow while the areas are deemed to be wet enough to cause damage to the soil or vegetation. Care shall be taken to use methods and mowers that will provide even, uniform mowed areas, and not damage adjacent vegetation and structures. Excessive clippings of sufficient magnitude to smother or retard grass growth shall be removed to allow growth of existing or new grass.

The Contractor shall begin mowing operations within two weeks after receipt of the Engineer's letter to begin mowing. If the Contractor fails to begin the work within that time period the Engineer shall notify the Contractor in writing that the work is not being prosecuted properly, and therefore, future progress payments may be withheld in accordance with Subsection 105.01 of the Standard Specifications.

223.03.2--Equipment. Equipment used for mowing operations shall be of sufficient size, type and condition to perform the work satisfactorily. Mowers may be rotary, flail, sickle or combination thereof as necessary to efficiently accomplish the work. Rotary mowers shall be equipped with safety chains or other devices to prevent flying stones, rocks, cans, etc. from striking persons or property. Change or adjustment of the equipment or operator may be required if at any time during the mowing operation, the Engineer determines that the equipment, or operators of the equipment, are not performing satisfactorily.

When required for the Contractor's mowing operations, appropriate traffic control devices shall be installed in accordance with the MUTCD.

223.04--Method of Measurement. Mowing will be measured by the acre. Litter removal and any required traffic control devices will not be measured for separate payment, but will be included in the fixed contract price for mowing.

223.05--Basis of Payment. When ordered by the Engineer, mowing will be paid for at the fixed contract unit price per acre indicated in the bid schedule, which price shall be full compensation for removing and disposing of litter, all equipment, tools, labor, traffic control devices and incidentals necessary to complete the work.

Payment will be made under:

223-A: Mowing

- per acre

SECTION 224 - SOIL REINFORCING MAT

224.01--Description. This work consists of furnishing, placing and maintaining a soil reinforcing mat on seeded or other designated areas in accordance with the requirements of the plans and these specifications.

224.02--Materials.

224.02.1--Preformed Permanent Mat. The soil reinforcing mat must be one from the Department's current "List of Approved Sources".

The Contractor will be permitted to furnish and install a multi-width mat with seams securely bonded by welding, stitching or other methods meeting the approval of the Engineer.

224.02.2--Stakes. Unless otherwise specified by the manufacturer of the soil reinforcing mat, stakes used to secure the mat shall be either:

- 1) sound 3/4-inch by 2 1/2-inch by 15 inch minimum, triangular shaped, wood stakes,
- 2) 3/16-inch by 18-inch metal pins with 1 1/2-inch round metal washer, or
- 3) double prong "U" shaped wire staples made from 9-gauge or heavier steel wire with an approximate length of eight inches after bending.

224.02.3--Acceptance Procedure. Prior to use, the Contractor must furnish the Engineer three copies of the manufacturer's certification for each shipment of soil reinforcing mat material stating the number of rolls furnished and that the material in the shipment conforms to the same composition as that originally approved by the Department. When metal pins or wire staples are used, also furnish the Engineer three copies of a certification from the manufacturer or distributor stating the pin and washer size for metal pins or wire size for staples for each shipment.

The certifications by the manufacturer or distributor will be prima facie evidence of the materials meeting the requirements of the specifications.

224.03--Construction Requirements.

224.03.1--General. The area(s) to be covered shall be prepared, fertilized and vegetated as specified in accordance with the requirements of the contract before the mat is installed. The planted area shall be to finish grade, smooth, and free of stones, clods, or trash. The vegetative mulch material shall be omitted from areas receiving the mat. The mat shall be installed immediately following the planting operations.

The installation of the mat material shall be performed in accordance with the requirements specified herein and the installation detail sheet in the plans.

Terminal slots, both upstream and downstream, shall be excavated a minimum of twelve inches deep and two feet wide across the full width of each area to be treated before placing the mat.

Transverse check slots shall be excavated a minimum of nine inches deep and six inches wide across the full width of the area to be treated at approximately 25-foot intervals along the entire length of the area.

Outer edge slots shall be excavated four inches deep by six inches wide along the actual perimeter of the mat installation for the full length of the area to be treated.

When possible, the mat installation shall begin at the downstream end and unrolled uphill in continuous contact with the soil. When two or more widths of mat are required to cover an area, they shall overlap a minimum of three inches. In cases where rolls are to be spliced lengthwise, the ends of the rolls shall overlap three feet minimum with the upgrade strip on top.

Temporary staking shall be required to place tension on the mat at crest of check slot for securing mat into slot and for proper alignment during installation.

The mat material shall be secured across the full width of the mat with stakes one-foot apart in all terminal, downstream and upstream, and transverse check slots. The stakes shall be placed three feet apart, with the diagonal edge facing upstream when using wood stakes, on outer edge slots, longitudinal overlaps and bonded seams on multi-widths. For longitudinal overlaps, one stake shall serve the overlapped edges of adjoining strips. The center of each strip including each strip between each bond, if multi-width rolls are used, and the center of ditch bottom shall be staked at six-foot intervals with the stakes placed broadside to the stream flow. When the center of a strip or the longitudinal overlap, including a bonded seam, falls within six inches of the center of ditch, the required ditch bottom stakes may be omitted. Where the rolls of mat are spliced lengthwise, the three-foot overlap shall be staked with two rows of stakes 30 inches apart with the stakes spaced approximately 18 inches apart in each row.

Wood stakes shall be driven to within approximately two to three inches of the ground surface. When metal pins are used, they shall be firmly embedded in the underlying soil with the attached washers flush with the ground surface. When wire staples are used, they shall be driven flush with the ground surface.

After the mat is placed and staked into all slots, the slots shall be backfilled with soil and compacted to the satisfaction of the Engineer.

Consideration may be given by the Engineer to the use of alternate staking

procedures when submitted by the Contractor upon recommendation of the manufacturer of the soil reinforcing mat and at least seven days prior to the proposed installation of the mat.

224.03.2--Protection and Maintenance. The Contractor shall maintain and protect the soil reinforcing mat until release of maintenance. Maintenance shall consist of repairs made necessary by erosion, wind, or any other cause.

224.04--Method of Measurement. Soil reinforcing mat will be measured by the square yard of surface area covered.

The additional mat material required for overlaps, slots and overwidth of strips will not be measured for payment.

224.05--Basis of Payment. Soil reinforcing mat, measured as prescribed above, will be paid for at the contract unit price per square yard, which price shall be full compensation for completing the work.

Payment will be made under:

224-A: Soil Reinforcing Mat - per square yard

SECTION 225 - GRASSING

225.01--Description. This work consists of furnishing, transporting, placing, plant establishment and all work necessary to produce a satisfactory and acceptable growth of grass. This work includes ground preparation, fertilizing, seeding and mulching necessary to establish a satisfactory growth of grass.

Ground preparation, light or standard, consists of plowing, loosening, and pulverizing the soil to form suitable beds for erosion control items in reasonably close conformity with the established lines and grades without appreciable humps or depressions. When grassing an area that has been previously planted with temporary grassing, a standard ground preparation will be required. The previously planted grasses shall be disked, tilled, plowed, etc. to assure that the existing temporary grasses are thoroughly mixed into the soil.

Fertilizing work consists of furnishing, transporting, spreading, and incorporating fertilizers.

Seeding consists of furnishing and planting seeds in a prepared seedbed; covering the seeds and compacting the seedbed; and providing plant establishment on all areas seeded. All the work shall be in accordance with the plans and these specifications.

Mulching consists of furnishing, transporting, placing, and anchoring vegetative mulch on slopes, shoulders, medians, and other designated areas.

225.02--Materials.

225.02.1--Fertilizers. Fertilizers for purposes of these specifications shall be understood to include standard manufactured products consisting of single or combination ingredients and agricultural limestone.

All fertilizer shall comply with the State fertilizer laws and the requirements of these specifications.

Fertilizers shall meet the requirements of Subsection 715.02.

225.02.2--Seeds. Seeds shall meet the requirements of Subsection 715.03, subject to the provisions herein. The Contractor shall acquire seed from persons registered with the Mississippi Department of Agriculture and Commerce.

Except for the germination requirements, bags of seeds properly labeled or tagged according to law and indicating characteristics meeting or exceeding the requirements of Subsection 715.03 will be acceptable for planting.

The Contractor should provide adequate dry storage facilities for seeds, and shall furnish access to the storage for sampling stored seed.

225.02.3--Mulching. The vegetative materials for mulch shall meet the requirements of Subsection 715.05.

Bituminous material for mulch shall be Emulsified Asphalt, Grade SS-1, meeting the requirement of Subsection 702.07.

225.03--Construction Requirements.

225.03.1--Ground Preparation.

225.03.1.1--General. Any equipment used for ground preparation shall be approved units suitable to perform the work and subject to the requirements of Subsection 108.05.

The Contractor shall take full advantage of weather and soil conditions, and no attempt shall be made to prepare soil when it is wet or in a condition which will not allow the soil to be properly tilled.

Light ground preparation should be used on areas where seeding is required to improve the coverage of partially vegetated areas.

Standard ground preparation should be used on areas designated to be solid sodded and unvegetated areas designated to be seeded.

225.03.1.2--Light Ground Preparation. Light ground preparation consists of scratching the surface with a close-tooth harrow, disk-harrow, or similar equipment. The depth of scratching should be at least three-quarters inch but not deep enough to damage existing grasses of the type being planted.

225.03.1.3--Standard Ground Preparation. Standard ground preparation consists of plowing or disk-harrowing and thoroughly pulverizing the areas immediately before the application of erosion control (vegetative) items. Unless otherwise specified, the pulverized and prepared seedbed should be at least four inches deep and shall be reasonably free of large clods, earthballs, boulders, stumps, roots and other objectionable matter. Incorporation of fertilizer and ground preparation may be performed simultaneously.

Aerating, moistening, or otherwise bringing the soil to a suitable condition for ground preparation shall be considered as incidental to the work and will not be measured for separate payment.

225.03.2--Fertilizing. The Contractor shall furnish all equipment necessary to properly handle, store, uniformly spread, and incorporate the specified application of fertilizer.

Unless otherwise specified in the contract, the Contractor shall incorporate bag fertilizer at a rate of 1000 pounds per acre of 13-13-13 commercial fertilizer. The equivalent rate of other type fertilizers will be allowed if the equivalent percentages of Nitrogen, Phosphorus and Potassium are obtained. The Contractor shall incorporate agricultural limestone at a rate of 5000 pounds per acre. Fertilization shall be applied uniformly on the areas to be planted or seeded and uniformly incorporated into the soil.

Fertilizers should be applied on individual areas of not more than three acres.

All fertilizer should be incorporated within 24 hours following spreading.

225.03.3--Seeding.

225.03.3.1--General. Prior to planting the seeds, ground preparation and fertilizing should have been satisfactorily performed.

Seeding may be required for temporary protection or for establishment of permanent ground cover. The plans will indicate temporary seeding.

The required type of seeds, minimum rates of application and planting dates of seeds are shown in the vegetation schedule on the plans. It is the Contractor's

responsibility to apply an ample amount of each type of seed to produce a satisfactory growth of grass and of the seed type required. At the completion of the project, a satisfactory growth of grass will be required. Reference Section 210 for satisfactory growth and coverage of dormant seed.

Legume seeds should be treated in accordance with Subsection 715.03.4 immediately before sowing. Seeds should be uniformly sown over the entire area with mechanical seeders. Seeds of different sizes may necessitate separate sowing. When legume seeds become dry, they should be re-inoculated.

Seeding should not be done during windy weather or when the ground is frozen, extremely wet, or in a condition which will not allow the soil to be properly tilled.

All seeds should be covered lightly with soil by raking, rolling, or other approved methods, and the area compacted with a cultipacker.

Mulching should be performed as soon as practicable.

225.03.3.2--Plant Establishment.. The Contractor should provide plant establishment on all areas seeded until release of maintenance.

Plant establishment should be provided for a minimum period of 45 calendar days after completion of seeding. In the event satisfactory growth and coverage has not been attained by the end of the 45-day period, plant establishment should be continued until a satisfactory growth and coverage is provided for at least one kind of plant as referenced in Section 210. The Contractor shall perform plant establishment on all areas of temporary seeding until the Engineer determines that the temporary seeding has served its purpose.

Plant establishment shall consist of preserving, protecting, watering, reseeding, mowing, and other work necessary to keep the seeded areas in satisfactory condition.

Areas requiring reseeding should be prepared and seeded and all other work performed as if the reseeding was the initial seeding. The types and application rates of fertilizer will be at the discretion of the Contractor.

225.03.3.3--Growth and Coverage. It shall be the Contractor's responsibility to provide satisfactory growth and coverage of grasses, legumes, or combination produced from the specified seeding.

Growth and coverage on seeded areas will be considered to be in reasonably close conformity with the intent of the contract when the type of vegetation specified, exclusive of that from seeds not expected to have germinated and

shows growth at that time, has reached a point of maturity where stems or runners overlap adjacent similar growth in each direction over the entire area.

225.03.4--Mulching.

225.03.4.1--Equipment. Mulching equipment should be capable of maintaining a constant air stream which will blow or eject controlled quantities of mulch in a uniform pattern. If asphalt is used, a jet or spray nozzle for applying uniform, controlled amounts of asphalt to the vegetative material as it is ejected should be located at or near the discharge spout.

Mulch stabilizers should consist of dull blades or disks without camber and approximately 20 inches in diameter. The disks should be notched, should be spaced at approximately 8-inch intervals, and should be equipped with scrapers. The stabilizer should weigh approximately 1000 to 1200 pounds, should have a working width of no more than eight feet, and should be equipped with a ballast compartment, so that weight can be increased.

225.03.4.2--Placement of Vegetative Mulch. Mulching should be placed uniformly on designated areas within 24 hours following seeding unless weather conditions are such that mulching cannot be performed. Placement should begin on the windward side of areas and from tops of slopes. In its final position, the mulch should be loose enough to allow air to circulate but compact enough to partially shade the ground and reduce erosion.

The baled material should be loosened and broken thoroughly before it is fed into the machine to avoid placement of unbroken clumps.

225.03.4.3--Rates of Application and Anchoring Mulch. The Contractor will designate the rate of application of vegetative mulch. The mulch should be anchored by either the use of a mulch stabilizer or by tacking with bituminous material. If a mulch stabilizer is used, the mulch should be punched into the soil for a minimum depth of one inch. If bituminous material is used, the rate of application should be 150 gallons per acre.

Where steep slopes or other conditions are such that anchoring cannot be performed satisfactory with a mulch stabilizer, the Contractor may elect to use bituminous material applied at the time or immediately following the mulch placement.

When mulch stabilizers are used, anchoring the mulch should be performed along the contour of the ground surface.

225.03.4.4--Protection and Maintenance. The Contractor should maintain and protect mulched areas until release of maintenance of the project. The Contractor should take every precaution to prevent unnecessary foot and vehicular traffic.

The Contractor should mow, remove or destroy any undesirable growth on all areas mulched as soon as any undesirable growth appears. This will prevent competition with the desired plants and to prevent reseeding of undesirable growth.

225.04--Method of Measurement. Grassing will be measured by the acre. Acceptance will be based on a satisfactory growth and coverage of seeds planted.

225.05--Basis of Payment. Grassing, measured as prescribed above, will be paid for at the contract unit price per acre, which will be full compensation for all required materials, equipment, labor, testing and all work necessary to establish a satisfactory growth of grass.

Payment will be made under:

225-A: Grassing - per acre

SECTION 230 - TREE AND SHRUB PLANTING

230.01--Description. Tree and shrub planting consists of furnishing, delivering, planting and establishing trees and shrubs of the types, species, and sizes indicated in accordance with these specifications and in reasonably close conformity with the locations shown on the plans or directed.

230.02--Materials.

230.02.1--Quality of Plant Materials. Unless otherwise specified, all trees and shrubs shall be nursery grown stock, strong, healthy, clean, well grown, and free from damage, insects, diseases, or rodents. They shall be root pruned and typical of the species. They shall possess a healthy, normal, and fibrous root system of sufficient size to insure plant growth. The branch system shall be of normal development and reasonably free from broken terminal growth or other objectionable disfigurements. Trees shall have reasonably straight stems, shall be well branched and symmetrical in accordance with their natural habits of growth, and shall be approved by a representative of the Department.

230.02.2--Plant Names. All scientific and common plant names shall conform to the "Standardized Plant Names" of the American Committee on Horticulture sponsored by the American Association of Nurserymen (AAN), current at the time of invitation for bids. All plant materials used shall be true to names and legibly tagged with name and size of material. There shall be no substitution for the kinds or sizes specified except by prior approval in writing by the Engineer.

230.02.3--Grading Standards. Grading of plants shall conform to the specifications for horticulture standards as adopted by the AAN, and current at

the time of invitation for bids.

230.02.4--Nursery Inspection and Plant Quarantine. All shipments of plants shall comply with all nursery inspection and plant quarantine regulations of the State of origin and destination, as well as with federal regulations governing the interstate movement of nursery stock. A valid copy of the certificate of inspection shall accompany each package, box, bale, or car load lot delivered.

230.02.5--Balled and Burlapped (B&B) Plants. Plants to be balled and burlapped shall be dug so as to retain as many fibrous roots as possible, and shall come from soil which will form a firm ball. The soil in the ball shall be the original and undisturbed soil in which the plant has been grown. The plant shall be dug, wrapped, transported, and handled so that the soil in the ball will not be loosened sufficiently to cause stripping of the small and fine feeder roots or to cause the soil to drop away from contact with the roots.

230.02.6--Container Grown (CG) Plants. Container grown plants shall be well-rooted and established in the containers in which they are sold. An established container grown plant shall be a plant transplanted into a container and grown in that container sufficiently long for new 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 hold the ball shape protecting the root mass during shipping and handling.

230.02.7--Inspection. All plant materials are subject to inspection at any time during the life of the contract by an authorized representative of the Department. Inspections before or during planting operations, however, shall not be construed as final acceptance of the plants involved.

230.02.8--Paint or Tree Wound Dressing. Paint required for cut surfaces shall be an asphalt base paint prepared especially for tree surgery and shall be approved before being used.

230.02.9--Collected Stock. Whenever "collected" stock is specified in connection with a species or variety, the stock shall not be nursery grown, but shall have been grown under natural conditions at the location from which it is acquired. When approved, collected stock may be obtained from areas no longer under cultivation as nursery stock.

230.02.10--Wrapping Material. The wrapping material shall be approved tree trunk wrapping paper.

The tying material to be used in wrapping trees shall be jute twine or other tying materials approved by the Engineer.

230.02.11--Water. The water applied as specified herein shall meet the

requirements of Subsection 714.01.5.

230.02.12--Topsoil. Topsoil used for backfilling shall meet the requirements of Subsection 715.01.

230.02.13--Fertilizers. Fertilizers shall meet the requirements of Subsection 715.08.

230.02.14--Mulch. Mulch shall meet the requirements of Subsection 715.07.

230.03--Construction Requirements.

230.03.1--Collected Plants. The Contractor shall notify the Engineer at least 24 hours in advance of digging local plants. These plants shall meet the requirements of the contract.

230.03.2--Digging of Plants. All plants, nursery grown or collected, shall be dug with care and skill immediately before shipping. Care shall be taken to avoid all possible injury to the plants or loss or damage to the roots. Particular care shall be given to the fibrous roots. After plants are dug, their roots shall not be permitted to dry out. If necessary to prevent drying out, they shall be puddled immediately upon digging. Dug plants shall not be exposed to artificial heat or to freezing temperatures.

230.03.3--Care and Handling of Plants. Unless otherwise allowed by the Engineer, all plants with bare roots that are not planted within four hours after delivery to the project shall be "heeled-in" in a moist soil.

The roots of "B&B" plants and container grown plants that are not planted within four hours upon delivery shall be adequately protected by a covering of soil, sand, sawdust, etc. and kept moist.

All heeled-in plants shall be properly maintained by the Contractor until planted. When plants are delivered in boxes, wrapped bundles, or other forms of closed packages, the packages shall be opened immediately after delivery and the plants inspected and dampened if necessary. While plants with bare roots are being transported to and from heeling-in beds, or being distributed for planting, the roots shall be protected from drying out by means of wet canvas, burlap, straw or by other approved methods.

230.03.4--Seasonal Limitations. Trees and shrubs shall be planted during the period specified in the plans. When soil and weather conditions are adverse to proper planting, the planting operations shall be suspended.

230.03.5--Excavation of Plant Holes. Plant hole excavation shall be roughly cylindrical in shape with the sides approximately vertical. Plants shall be

centered in the holes with the trunk locations as shown on the plans. The soil on the sides and in the bottom shall be loosened by scarifying or other approved methods.

Holes for bare-root plants shall be at least six inches larger than the maximum root spread. Holes for B&B, and CG plants shall be large enough to allow at least six inches of backfill below and around the earth ball. When a tree spade is used, the plant hole and the earth ball shall be approximately equal in size.

230.03.6--Pruning. Before the plant is placed in the plant hole, bruised or broken parts of minor roots shall be cut off in a satisfactory manner.

The tops of all plants shall be properly pruned, either before or immediately after planting. Pruning shall consist of thinning out and/or heading back of stems and top branches as may be necessary according to generally accepted horticultural practices and according to the shape, size, and condition of the individual plant. All cut surfaces one inch or more in diameter shall be painted with an approved asphalt base tree paint.

230.03.7--Planting, Backfilling and Watering. The plant shall be placed in the prepared plant hole at the proper position in regard to depth, alignment, final grade of the surrounding ground, and vertical placement of the trunk, and this position shall be maintained during subsequent backfilling and water operations. Unless otherwise specified or directed, plants shall stand, at the time of completion of planting operations, at the same depth as they stood in the nursery, container or field.

230.03.7.1--Plants with Bare Roots. With the plant in its proper position, the plant hole shall be carefully filled to within one-half to two-thirds its capacity with topsoil. The topsoil shall be carefully placed, worked around the roots, and firmed so as to avoid bruising or breaking the roots. When this partial backfilling and firming has been completed, the soil in the plant hole shall be saturated with water.

The remainder of the topsoil backfill shall then be placed, firmed, and brought to an approved moisture content. The top few inches of soil may be allowed to remain loose.

When deemed necessary, water rings shall be constructed of suitable firmed earth six inches high to encompass the plant hole for the purpose of retaining water.

230.03.7.2--Balled and Burlapped Plants. The plant shall be handled by the ball and placed in the hole in such a manner that the soil will not be loosened from the roots. After the hole has been partially backfilled and the topsoil firmed under and around the ball, the burlap shall be cut away from the stem of the

plant. The hole shall then be saturated with water to the elevation of the top of the topsoil. Backfilling and firming shall then be completed in a manner to avoid loosening the soil of the root ball. Water shall then be applied as for bare root plants, and water rings shall be constructed as deemed necessary.

230.03.7.3--Container Grown Plants. Immediately prior to placing the plant in the hole, the container shall be removed so as not to disturb the ball of soil that contains the root system. The planting procedure shall be as specified above for balled and burlapped plants.

230.03.7.4--Tree Spade Plants. When specified or permitted, a tree spade may be used in digging plant holes and planting. This method of planting shall be in accordance with good horticultural practices meeting the approval of the Engineer.

230.03.8--Fertilizer. Fertilizer shall be the types and shall be applied at the rates and in the manner specified. The fertilizer shall be applied during backfilling operations in a manner that will insure proper placement of the fertilizer and avoid injury to the roots.

230.03.9--Mulching. Mulch shall be the types and shall be applied at the rates specified as a top layer on the backfilled plant hole.

230.03.10--Wrapping. The trunks of smooth-barked trees shall be wrapped with an approved material prepared especially for tree wrapping.

Wrapping shall begin two inches below the ground line and continue upward to the lower-most branches, and shall be firmly placed and securely fastened in a manner that will not injure the trunk of the tree.

230.03.11--Staking and Guying. All trees shall be staked or guyed at the time of planting.

Trees larger than two-inch caliper shall be guyed from at least three points with double strands of 12-gauge wire. Guy wires shall be anchored to 2-inch by 2-inch by 18-inch stakes driven to the extent that the top of the stake is at approximately three inches above the finish ground. Tie wires shall be securely fastened to the tree by means of a collar of rubber hose or other approved material. Guy wires shall be tightened and kept tight by twisting.

Trees, 2-inch and smaller caliper, may be guyed as specified above or staked with two stakes, 2-inch by 2-inch minimum, set 18 inches in the ground. The tree shall be midway between the stakes and held firmly in place by two strands of 12-gauge, soft wire enclosed in rubber hose or other approved covering. The wire shall then be nailed or stapled to the stakes to prevent slippage.

230.03.12--Surplus Excavation. Surplus excavated material from plant holes shall be disposed of by scattering or as directed. All debris and other objectionable material shall be removed from the site and the area cleaned up and left in neat condition.

230.03.13--Restoration of Plants. At the earliest possible time during the planting seasons, the Contractor shall replace at no additional cost to the Department all dead, damaged, or missing plants.

230.03.14--Plant Establishment.

230.03.14.1--General. The Contractor shall use good horticultural practices to keep all plants installed in a healthy condition until final inspection for release of maintenance.

230.03.14.2--Weed and Grass Control. The area around planted trees and shrubs shall be maintained reasonably free of weeds and grass within a minimum radius of two feet from each plant trunk or the entire plant pit or bed. Where practicable to effectively accomplish this work without removal of the mulch, removal will not be required. If it is necessary to remove the mulch to effectively accomplish this work, removal and replacement shall be performed at no additional cost to the Department. Weed and grass control shall be performed during the time intervals specified on the plans.

230.03.14.3--Watering. Water necessary to thoroughly wet the roots of all trees and shrubs shall be applied in accordance with the provisions shown on the plans.

230.03.14.4--Fertilization. Each tree or shrub shall be fertilized with the types of fertilizer, at the rates, and during the periods shown on the plans.

230.03.14.5--Mulching. Mulch material shall be repositioned, supplemented, or replaced as required during the period shown on the plans.

230.03.14.6--Pruning. All trees and shrubs shall be properly pruned with approved pruning shears. Pruning shall consist of removing all dead or diseased wood and new growth as necessary to maintain natural shape of the plants. Pruning shall be during the periods specified on the plans.

The Contractor's responsibility for plant establishment work will end on October 1 following the second growing season; however, the Contractor shall be fully responsible for protection, preservation, and maintenance of all plantings until final inspection for release of maintenance.

230.03.14.7--Inspection of Plants. Inspection of planted trees and shrubs will be made by the Engineer before the end of the first full growing season. On or about October 1, determinations will be made by the Engineer of the survival of

each size and type of plant. The Engineer will either require replacement of dead, defective, or missing plants, or not require replacement at certain locations.

230.03.14.8--Replacement of Plants. The Contractor may be directed by the Engineer to replace certain dead, defective, or missing plants. Replacement plants shall be made at the earliest practicable time during the planting season following the first growing season. All replacement plantings shall be in accordance with the requirements applicable to initial planting.

230.03.14.9--Non-Replacement of Plants. Certain plants found to be dead, defective, or missing may be ordered removed and not replaced if non-replacement would not adversely affect the planting design.

230.04--Method of Measurement. Trees and shrubs, in place, undamaged and healthy at the time of final inspection, will be measured per each for each species, size, and type specified.

Furnishing, installation, staking or guying, weed and grass control, pruning, removal of dead and defective trees and shrubs or missing trees and shrubs will not be measured for separate payment.

Topsoil used for backfilling initial plantings only will be measured and paid for under Section 211.

Fertilizer ordered and acceptably used will be measured and paid for under Section 232.

Mulch ordered and placed in accordance with the requirements of these specifications will be measured and paid for under Section 233.

Water ordered and acceptably used will be measured and paid for under Section 219.

Construction of water rings, haul and disposal of surplus or unsuitable excavation, and other plant establishment work required in the contract shall be considered incidental to tree or shrub planting and will not be measured for separate payment.

Measurement for payment will be made in the following sequence:

When all plants have been planted in accordance with the contract, 65 percent of the unit price will be allowed.

When the inspection of plants at the end of the first growing season (October 1) as set out in Subsection 230.03.14.7 determines that the survival rate exceeds 65 percent for one or more of the individual species, sizes and types,

the same percentage of the unit price will be allowed as the survival rate, but not to exceed 75 percent.

At the end of the second planting season and after all ordered replacement plants have been properly planted and the survival rate at the end of the first growing season was determined to exceed 75 percent for one or more of the individual species, sizes and types, the same percentage of the unit price will be allowed as the survival rate, but not to exceed 80 percent.

At the end of the second growing season, 90 percent of the unit price will be allowed for surviving trees and shrubs.

Upon release of maintenance, 100 percent of the unit price will be allowed for surviving trees and shrubs meeting the requirements of the contract.

230.05--Basis of Payment. Accepted quantities of trees and scrubs of the specified species, size, and type will be paid for at the contract unit price per each, which price shall be full compensation for completing the work.

Payment will be made under:

230-A: Shrub Planting, Designation - per each

230-B: Tree Planting, Designation - per each

SECTION 231 - TREE SEEDLING PLANTING

231.01--Description. Tree seedling consists of furnishing, delivering and planting tree seedlings of the species, type and size indicated, in accordance with these specifications and in reasonably close conformity with the locations shown on the plans or directed.

231.02--Materials.

231.02.01--Quality and Grading Standards. The seedlings shall be nursery grown and equal to the best quality produced by and graded according to the standards of the Mississippi State Forestry Commission, United States Forest Service, or American Association of Nurserymen (AAN).

231.02.2--Nursery Inspection and Plant Quarantine. All shipments of seedlings shall comply with all nursery inspection and plant quarantine regulations of the state of origin and destination, as well as with federal regulations governing the interstate movement of nursery stock. A valid copy of the certificate of inspection shall accompany each package, box, bale, or car load lot delivered.

231.02.3--Plant Names. All scientific and common plant names shall conform to the "Standardized Plant Names" of the American Committee on Horticulture sponsored by the AAN, current at the time of invitation for bids. All plant materials used shall be true to names and legibly tagged with name and size of material. There shall be no substitute for the kinds or sizes specified except by prior approval in writing by the Engineer.

231.02.4--Inspection. All seedlings are subject to inspection at any time during the life of the contract by an authorized representative of the Department. However, inspections before or during planting operations shall not be construed as final acceptance of the seedlings.

231.02.5--Fertilizer. Fertilizer(s) shall meet the applicable requirements of Section 213 or Section 232, as specified.

231.03--Construction Requirements.

231.03.1--Equipment. The furnished tools and equipment for digging plant holes, slits or trenches shall be adequate to perform the excavation to the proper size and depth such that twisted, balled, or "U" roots will not result. All equipment and tools shall meet the approval of the Engineer.

231.03.2--Seasonal Limitations. Seedlings shall be planted during the period specified on the plans. When soil and weather conditions are adverse to proper planting, the planting operations shall be suspended.

231.03.3--Care and Handling. All seedlings shall be planted within fourteen days after pick-up from the nursery. The seedlings shall be stored in a cool, damp, shady place and the roots kept moist at all times until planted. Seedlings allowed to dry out in route to planting site, in storage for daily planting or during handling by individual planters will be unacceptable for planting.

231.03.4--Spacing. The spacing of seedlings shall be as specified on the plans, or as directed by the Engineer.

231.03.5--Area Preparation. All existing vegetation within the area shall be mowed to a height of approximately four inches prior to planting the seedlings.

231.03.6--Planting. When planting seedlings using a dibble bar or mattock, the ground shall be cleared of vegetation approximately one square foot at the point of planting. One seedling per trash-free hole shall be planted in the center of the cleared area at the depth grown in the nursery; however, a tolerance of two inches low will be permitted for pine seedlings. All slits, holes, or trenches shall be closed and the soil packed firmly around the planted seedlings.

Mechanical seedling planters may be used to plant seedlings in relatively flat

areas suited to power equipment when approved. The planter shall clean a strip of an approved width and in an approved manner. One seedling shall be planted in the trash-free slit or trench at the depth grown in the nursery; however, a tolerance of two inches low will be permitted for pine seedlings. All plant slits or trenches shall be closed and the soil packed firmly around the planted seedling.

When the plant holes cannot be dug large enough for the seedling's root system using dibble bar, mattock or mechanical planter, other approved methods shall be used. In any case, roots of seedlings shall not be pruned or broken.

231.03.7--Restoration of Seedlings. At the earliest possible time during the planting seasons and at no additional cost to the Department, the Contractor shall replace all dead, damaged, or missing seedlings.

231.03.8--Application of Fertilizer. Fertilizer shall be the types and shall be applied at the rate and in the manner specified.

231.03.9--Inspection of Seedlings. Inspection of planted seedlings will be made by the Engineer before the end of the first full growing season. On or about October 1, determinations will be made by the Engineer of the survival of each species of seedling. The Engineer will divide the portion of the project on which each species of seedling is planted into lots as deemed necessary to represent segments of the work in which survival characteristics are similar. At the discretion of the Engineer, the percentage of survival of seedlings will be determined by sampling from each of the lots selected or the percentage of survival in any lot may be determined from the ratio of the actual count of seedlings within the lot at the time of the inspection to the total number of seedlings required to plant the lot in accordance with the spacing requirements of the contract.

In the determination of the percentage of survival sampling from areas planted, the Engineer will select at random, from within each lot selected, one or more increments, each of which shall be not less than one-tenth acre or ten percent of the area of the lot, whichever is smaller. The area of each increment selected within the lot will be measured and, if more than one increment is selected, their areas will be combined. The number of surviving seedlings within the selected increment(s) of the lot will be counted. The percentage of the survival of the lot will be established by dividing the combined count of surviving seedlings thus obtained by the total number of seedlings required for the combined areas of the increments when planted in accordance with the spacing requirements of the contract.

The survival percentage of each species for the project will be established by multiplying the survival percentage for each lot by the area of each such lot and dividing the sum of these products by the total area planted.

As determined during this inspection, the Engineer will either require replacement of dead, defective, or missing seedlings or not require replacement of such seedlings at certain locations.

231.03.10--Replacement or Non-Replacement of Seedlings.

231.03.10.1--Replacement. The Contractor may be directed by the Engineer to replace certain dead, defective, or missing seedlings. Replacements shall be made at the earliest practicable time during the planting season following the first growing season. All replacement plantings shall be in accordance with the requirements applicable to initial planting.

231.03.10.2--Non-Replacement. Certain seedlings found to be dead, defective, or missing may not be ordered replaced if non-replacement would not adversely affect the planting design.

231.04--Method of Measurement. Seedlings of the type specified, in place, undamaged, and healthy at the time of final inspection, will be measured per thousand seedlings.

At the discretion of the Engineer, the total number of acceptable seedlings in place at the time of final inspection will be determined by sampling from areas planted or by actual count of acceptable surviving seedlings. The Engineer will divide the portion of the project on which each species of seedlings is planted into lots as deemed necessary to represent areas of the work on which survival characteristics are similar. Within each such lot, in the case of determination by sampling, the Engineer will select at random one or more increments, each of which shall be not less than one-tenth acre or ten percent of area of the lot, whichever is smaller. The area of the lot will be determined and the area of each increment selected within the lot will be measured and, if more than one increment is selected within the lot, the areas of such increments will be combined. The number of acceptable surviving seedlings within the increment or increments, as the case may be, will be counted. The number of acceptable surviving seedlings within the increment or increments thus determined shall be multiplied by the ratio between the area of the lot and the area of the increment or increments, as the case may be, to give the total number of surviving seedlings in the lot.

In lieu of such determination by the specified sampling method, the Engineer may elect to determine the total number of acceptable surviving seedlings in place in any lot at the time of final inspection by actual count.

The number of acceptable seedlings of each species in place on the project at the time of final inspection shall be the summation of the number of acceptable surviving seedlings of each species determined for each lot.

Fertilizer(s) ordered and acceptably used will be measured and paid for under Section 213 or Section 232.

Measurement for payment will be made in the following sequence:

When all seedlings have been planted in accordance with the contract, 65 percent of the unit price will be allowed.

When the inspection of seedlings at the end of the first growing season (October 1) as set out in Subsection 231.03.9 determines that the survival rate exceed 65 percent for one or more of the individual species, sizes and types, the same percentage of the unit price will be allowed as the survival rate, but not to exceed 75 percent.

At the end of the second planting season and after all ordered replacement seedlings have been properly planted and the survival rate at the end of the first growing season was determined to exceed 75 percent for one or more of the individual species, sizes and types, the same percentage of the unit price will be allowed as the survival rate, but not to exceed 80 percent.

At the end of the second growing season, 90 percent of the unit price will be allowed for surviving seedlings, trees and shrubs.

Upon release of maintenance, 100 percent of the unit price will be allowed for surviving seedlings, trees and shrubs meeting the requirements of the contract.

231.05--Basis of Payment. Seedlings of the type specified, measured as provided above, will be paid for at the contract unit price per thousand, which price shall be full compensation for completing the work.

Payment will be made under:

231-A: Seedlings, Designation - per thousand

SECTION 232 - FERTILIZER FOR WOODY PLANT MATERIAL

232.01--Description. This work consists of furnishing, transporting, and placing fertilizer under or around the roots of trees, shrubs, liner plants, and other plant materials in accordance with the requirements shown on the plans and in these specifications.

232.02--Materials. The fertilizer for woody plant materials shall meet the requirements of Subsection 715.08.

232.03--Construction Requirements. Unless otherwise specified, the

Contractor will have the option of using fertilizer packets or tablets. A one-ounce packet is equivalent to four five-gram tablets; two ten-gram tablets; or one twenty-one-gram tablet. The required number and size of packets or tablets for each type of plant material will be specified on the plans.

When using packets, they shall be placed beneath the roots in the backfill material during the planting operation. Care shall be taken to insure that packets remain unopened and lie in a horizontal position.

When using tablets, the plant shall be positioned in the plant hole and backfilled no higher than halfway up the root ball. The specified number of tablets, designated on the plans or determined by the Engineer, shall be spaced approximately equal distances around and immediately adjacent to the root ball. The backfilling operation shall then be completed in accordance with the planting specifications.

232.04--Method of Measurement. Fertilizer for woody plant material will be measured by the thousand tablets or packets.

Fertilizer tablets, placed as specified and accepted, will be measured in place by the thousand tablets.

Fertilizer packets, placed as specified and accepted, will be measured in place by the thousand packets. In the event fertilizer tablets are substituted for fertilizer packets as provided in Subsection 232.03, the quantity of tablets placed and accepted will be converted to packets and included in the measurement for payment for fertilizer packets.

232.05--Basis of Payment. Fertilizer for woody plant material, measured as prescribed above, will be paid for at the contract unit price per thousand tablets or per thousand packets, as specified. Prices thus paid shall be full compensation for completing the work.

Payment will be made under:

232-A: Fertilizer for Woody Plant Material,
Designation, Size - per thousand

SECTION 233 - MULCH FOR WOODY PLANT MATERIAL

233.01--Description. This work consists of furnishing, transporting, placing, and maintaining the kinds of mulch specified in accordance with the requirements of these specifications and in reasonably close conformity with the dimensions and details shown on the plans or established.

233.02--Materials. The mulch for woody plant materials shall meet the applicable requirements of Subsection 715.07.

233.03--Construction Requirements.

233.03.1--General. All work shall conform to good horticultural practices.

233.03.2--Placement. The specified kinds of mulch shall be placed uniformly on designated areas within 24 hours following planting. The areas to be mulched shall be free of undesirable debris and weeds or grass. The mulch shall be placed to the specified depth by an approved method and in a manner that will present a neat uniform appearance. The mulch shall be kept within the designated areas without undue scattering. The areas to receive mulch and the rates of application will be shown on the plans or designated by the Engineer. The tolerances from the specified rates will be as determined by the Engineer to be reasonable.

233.03.3--Protection and Maintenance. The Contractor shall maintain and protect mulch areas until release of maintenance of the project. The Contractor shall take every precaution to prevent unnecessary foot and vehicular traffic on the mulched areas and shall repair and restore immediately all displacement of mulch without additional compensation.

233.04--Method of Measurement. Mulch for woody plant materials will be measured by the cubic yard or ton as specified herein.

Tree bark mulch will be measured by the cubic yard as packaged or baled. Unless the Engineer determines otherwise, the volume shown on the manufacturer's label or tag will be used to determine the volume. Aggregate mulch will be measured by the cubic yard (LVM). Straw mulch will be measured in tons. The weight for measurement will be the product of the number of bales of straw mulch acceptably placed and the average weight per bale as determined on approved scales provided by the Contractor.

233.05--Basis of Payment. Mulch of the kinds, types, or classes specified will be paid for at the contract unit price per cubic yard for tree bark mulch, per cubic yard (LVM) for aggregate mulch, and per ton for straw mulch, which prices thus paid shall be full compensation for completing the work.

Payment will be made under:

- 233-A: Tree Bark Mulch, Type - per cubic yard
- 233-B: Aggregate Mulch - per cubic yard
- 233-C: Straw Mulch, Class - per ton

SECTION 234 - SILT FENCE

234.01--Description. This work consists of furnishing, constructing and maintaining a water permeable filter type fence for the purpose of removing suspended soil particles from the water passing through it in accordance with the requirements shown on the plans and these specifications. Fence measured and paid as temporary shall be removed.

It is understood that measurement and payment for silt fence will be made only when ordered and a pay item is included in the proposal. The quantities are estimated for bidding purposes only, and may be varied dependent upon actual conditions which occur during construction of the project.

234.02--Materials. Geotextile fabric, posts, staples and woven wire backing, when required, shall meet the requirements of Subsection 714.13.

234.03--Construction Requirements.

234.03.1--Placement of Fence. The silt fences shall be constructed at the locations shown on the plans or as directed by the Engineer.

All posts shall be installed so that no more than three feet of the post shall protrude above the ground. Extra post for bracing shall be installed as directed by the Engineer. The woven wire shall be securely fastened to the wood posts with staples. When metal posts are used, the wire shall be fastened to the post with wire or other approved means. The geotextile shall be attached to the wire fence by wire or other approved means. The bottom edge of the geotextile shall be buried six inches below ground surface to prevent undermining. When splicing of the geotextile is necessary, two posts shall be installed approximately 18 inches apart and each piece of geotextile shall be fastened to both posts.

The geotextile will be rejected if it has defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, storage or installation.

Type II geotextile may be installed without the woven wire fence backing provided all of the following conditions are met:

- (a) Post spacing is reduced to six feet or less.
- (b) The geotextile has been approved by the Engineer and the manufacturer recommends its use without the woven wire backing.
- (c) Fence posts shall be inclined toward the runoff source at an angle of not more than 20° from vertical.
- (d) Geotextile shall be attached to the posts in such manner that purpose

intended is satisfied and maintained.

234.03.2--Maintenance and Removal. The Contractor shall maintain the silt fence and the geotextile shall be removed and replaced when deteriorated to such extent that it reduces the effectiveness of the silt fence. Excessive accumulations against the fence shall be removed and disposed of as directed by the Engineer.

Unless otherwise directed, all temporary silt fences shall be removed. Upon removal, the Contractor shall remove and dispose of any excess silt accumulations, dress the area to give a pleasing appearance and vegetate all bare areas in accordance with the contract requirements. The temporary fence materials will remain the property of the Contractor and may be used at other locations provided the materials are acceptable to the Engineer.

234.04--Method of Measurement. Silt fence will be measured by the linear foot.

234.05--Basis of Payment. Silt fence, measured as prescribed above, will be paid for at the contract unit price per linear foot which shall be full compensation for completing the work.

Payment will be made under:

- 234-A: Temporary Silt Fence - per linear foot
- 234-B: Permanent Silt Fence - per linear foot

SECTION 235 - TEMPORARY EROSION CHECK

235.01--Description. This work consists of furnishing, constructing and maintaining baled hay or straw erosion checks for the retention of soil along the toe of fill slopes, around inlets, swale areas, small ditches, sediment basins and other areas as directed by the Engineer in accordance with the requirements shown on the plans and these specifications. Also, the work includes removing and disposing of the erosion checks and silt accumulations as directed by the Engineer.

Measurement and payment for temporary erosion checks will be made only when ordered and a pay item is included in the bid schedule of the proposal. The quantity is estimated for bidding purposes only and will be dependent upon actual conditions which occur during construction of the project.

235.02--Materials. Approved Type I or II baled hay or straw material shall be rectangular in shape with a minimum length of 32 inches and shall meet the requirements of Subsection 715.05. The wooden stakes used in securing the

baled material in place shall be approximately 2 inches by 2 inches x 34 inches meeting the approval of the Engineer.

235.03--Construction Requirements.

235.03.1--General. The erosion checks shall be constructed at the locations and according to the requirements shown on the plans or as directed by the Engineer. Erosion checks required along the toe of fill slopes shall be constructed prior to grading operations at the site. For other locations, the erosion checks shall be constructed when directed by the Engineer.

The soil shall be excavated at least three inches in depth to embed the baled material. After securing in place, a sufficient quantity of the excavated material shall be placed around the erosion check and compacted to prevent undermining.

235.03.2--Maintenance and Removal. The Contractor shall maintain the erosion checks and remove and dispose of silt accumulations as directed by the Engineer.

When the erosion checks are no longer needed, they shall be removed and the Contractor shall dispose of silt accumulations and treat the disturbed areas in accordance with the contract requirements.

235.04--Method of Measurement. Erosion check will be measured per each by actual count of the total bales used in constructing, replacing and maintaining the erosion checks.

235.05--Basis of Payment. Erosion check, measured as prescribed above, will be paid for at the contract unit price per each and which shall be full compensation for completing, maintaining and removal of the erosion checks and the removal and disposal of silt accumulations.

Payment will be made under:

235-A: Temporary Erosion Check - per each

SECTION 236 - TEMPORARY SILT BASINS

236.01--Description. This work shall consist of excavation and satisfactory disposal of all materials excavated in the construction, clean out, and maintenance of silt basins. This work may also consist of maintenance and removal of existing silt basins constructed on previous projects.

The Contractor shall construct earth dikes and overflow spillways, furnish and install outfall pipe, perforated elbows, perforated risers, and trash racks in silt

basins where shown on the plans or as directed by the Engineer. The quantity of silt basins to be placed will be affected by the actual conditions which occur during the construction of the project.

It is understood that measurement and payment for silt basins will be made only when shown on the plans or ordered by the Engineer, and a pay item is included in the bid schedule of the proposal. The quantity is estimated for bidding purposes only and will be dependent upon actual needs during construction of the project.

236.02--Blank.

236.03-Construction Requirements.

236.03.1-General. The Contractor shall excavate silt basins to the dimensions and at the locations shown on the plans or as directed by the Engineer. The silt basins, new or existing, shall be cleaned out as frequently as necessary to have at least 50% of the basin capacity available at all times. The silt basins shall be completely cleaned out and the slopes shaped and dressed for seeding and mulching prior to completion of the project unless otherwise directed by the Engineer. Grassing shall be done in accordance with the provisions contained in the contract for the roadway and will not be measured as a separate item.

236.03.2--Maintenance and Removal. The silt basins shall be maintained so they will function properly until the Contractor is released from maintenance, all as determined by the Engineer.

All excavated materials shall be utilized in the construction of basins or roadway embankments except where otherwise directed by the Engineer. Materials not used shall be disposed of as directed by the Engineer.

Upon removal of a silt basin, the pipe, elbows, risers and trash racks may be used at other locations provided they are in condition acceptable to the Engineer. Pipe, elbows, risers and trash racks will become the property of the Department upon completion of the project.

236.04--Method of Measurement. Silt basin will be measured per each. Once a silt basin has been constructed, it shall be paid for at the unit price per each.

Maintenance and removal of existing silt basin will be measured per each. Once an existing silt basin has been cleaned out, it shall be paid for at the unit price per each. Additional clean outs or maintenance may need to be performed on that silt basin throughout the length of the project.

236.05--Basis of Payment. Silt basin will be paid for at the contract unit price per each, which price shall be full compensation for construction, maintaining,

removal unless noted otherwise, grassing and any other work required to make the basin function. Maintenance and removal of existing silt basin will be paid for at the contract unit price per each, which price shall be full compensation for maintaining, removal, grassing and any other work required to complete the work.

Payment will be made under:

236-A: Silt Basin, Type - per each

236-B: Maintenance and Removal of Existing Silt Basin * - per each

* Type may be specified

SECTION 239 - TEMPORARY SLOPE DRAINS

239.01--Description. This work consists of furnishing materials for, constructing and maintaining temporary slope drains, to include berms, pipe and riprap, as directed by the Engineer in accordance with the requirements shown on the plans and these specifications to control soil erosion and water pollution. Also, the work includes removing and disposing of the temporary slope drains.

This temporary erosion control provision shall be coordinated with the permanent erosion control features to assure economical, effective and continuous erosion control throughout the construction period.

Measurement and payment for temporary slope drains will be made only when a pay item is included in the bid schedule of the proposal. The quantity is estimated for bidding purposes only and may vary depending upon actual construction requirements.

239.02--Materials. The temporary shoulder berm may be constructed from embankment material.

The temporary pipe shall be 8-inch minimum diameter and leak proof.

The temporary riprap shall be hard, durable stones or broken concrete, angular in shape and shall be of sufficient size to prevent scour where installed.

239.03--Construction Requirements. Temporary slope drains shall be constructed at the intervals and locations designated or deemed appropriate by the Contractor and approved by the Engineer for channeling runoff waters down embankment slopes and according to the requirements shown on the plans.

Slope drains shall be adequately anchored to the slopes and their outlets constructed or placed to prevent erosion.

Berms may be constructed from embankment material using the heel of a motor grader, bulldozer blade or other approved equipment and compacted using the wheels or tracks of same equipment.

Riprap shall be placed in accordance with the plans where the pipe outlet location is subject to scour. The riprap may be end dumped.

Pipe shall be placed in accordance with the plans and extended as required to coincide with the height of embankment by the end of each work day.

Prior to the suspension of grading operations each day, the Contractor shall shape the earthwork in a manner that will direct storm water runoff to the temporary slope drain installations.

The temporary slope drains shall be operated and maintained by the Contractor in an acceptable functional condition until the slopes are protected with permanent erosion control measures.

When the temporary erosion and pollution control installations are no longer required, the Contractor shall remove and dispose of all materials and restore the areas by establishing growth and coverage of vegetative items as required for the remainder of the project.

239.04--Method of Measurement. Temporary slope drains will be measured by the linear foot of temporary pipe, which includes berms, riprap, and pipe including elbows or special sections. Measurement shall be along the line and grade of the pipe installation from end to end along the centerline of the pipe installed and accepted.

Temporary shoulder berms and temporary riprap will not be measured for separate payment. Their costs shall be included in the per linear foot price bid for temporary slope drains.

239.05--Basis of Payment. Temporary slope drains, measured as prescribed above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for completing and maintaining the work and for the removal and disposal of, when no longer required, all items comprising the temporary slope drains.

Payment will be made under:

239-A: Temporary Slope Drains

- per linear foot

DIVISION 300 - BASES

The sections in the 300 series include the specification requirements for bases, shoulders, and other work closely related to the construction of the pavement foundation and shoulders.

The term "course" used in this series of sections shall be understood to mean a structural component of specified thickness. A course may consist of one or more layers.

Shoulder courses shown on the plans to be constructed separately from base courses shall be performed in accordance with the provisions and requirements of Section 320.

SECTION 304 - GRANULAR COURSES

304.01--Description. This work consists of furnishing granular materials and the construction of one or more courses of base, shoulders, or other required construction on a prepared foundation in reasonably close conformity with the lines, grades, and typical cross sections shown on the plans or established by the Engineer.

304.02--Materials.

304.02.1--General. Unless otherwise specified, materials used in this work shall conform to the requirements of Subsections 703.04 & 703.07. General conditions governing the use of materials shall be as set out in Section 106.

304.02.2--Sampling, Testing and Acceptance. A minimum of one random sample will be obtained from the roadway for each 1000 cubic yards or 1400 tons for determining acceptance of the material for gradation, liquid limit and plasticity index. When borderline or failing results are obtained the Engineer may increase the sampling frequency.

When a roadway sample fails to meet the requirements of the specifications additional samples will be taken along the roadway for determining the limits of the inferior material. Such inferior material shall be corrected or removed and replaced at no additional costs to the State.

304.03--Construction Requirements.

304.03.1--Equipment. When measurement for payment is to be made by the ton, the Contractor shall furnish approved platform scales capable of weighing the entire loaded vehicle. Scales and their use shall be in accordance with the requirements set out in Subsection 401.03.2.1.11, except they shall be installed at

an approved location on or near the project.

Rollers shall be of sufficient number, type, size, and weight to accomplish the required compaction.

Watering equipment shall have pressurized spray bars with suitable nozzle openings.

304.03.2--Preparation of Grade. The foundation on which granular material is to be placed shall be prepared as set out in Section 321. A section of prepared roadbed of sufficient length to allow time for inspection, test, necessary corrections, and approval shall be maintained at all times ahead of placing material.

304.03.3--Placing of Materials. The Contractor shall be responsible for furnishing a material that meets the requirements of the contract and in such quantity to produce the specified compacted thicknesses. All material placed in excess of the tolerances allowed in Section 321 shall be removed and placed at other approved locations, or removed and hauled off the project without compensation.

A course whose compacted thickness is designated to be more than eight inches shall be constructed in two or more layers of approximately equal thickness. The maximum compacted thickness of any one layer shall not exceed eight inches.

No granular materials shall be placed while frozen or placed on frozen materials.

When the Engineer determines that in-place material, including the top portion of the design soil, is wet to the degree that there is a possibility of rutting, deforming, or displacing the underlying material, the hauling operation shall be suspended.

The Contractor shall produce such material as is necessary to meet the specifications for gradation, liquid limit and plasticity index and shall make such corrections as are necessary or shall remove and replace, at no additional cost to the State, any deficient material placed in the work. In all cases of correcting deficiencies on the roadbed, the Contractor shall be fully responsible for any damage to the underlying course(s) and other work.

304.03.4--Blending. After the material has been initially shaped, the entire volume of material for the course or layer being placed shall be processed and blended by blading in such a manner and as many times as necessary to produce a course visually uniform in color and texture. Care shall be exercised during the blending process to prevent contamination with underlying material. The Contractor shall be fully responsible for damage to or contamination with underlying or other unlike material and shall make corrections as necessary at no

additional cost to the state.

When granular material is required to be placed adjacent to pavement in place, blending shall be performed to the satisfaction of the Engineer prior to placement of the material on shoulders.

304.03.5--Shaping, Compacting, and Finishing. Each course or layer of material shall be shaped to the required section, watered or aerated as necessary to provide the needed moisture content for compaction, and compacted. Throughout the compaction operation, the shape of the course or layer shall be maintained by blading and rolling so that the aggregates are uniformly distributed and firmly keyed.

Shaping and compaction shall be carried out in a manner that will prevent lamination and shall continue until the entire depth and width of the course or layer has reached the required density. Surface compaction and finishing shall be performed so as to produce a smooth, closely knit surface that is free from lamination, cracks, ridges or loose material. The finished surface shall conform, within allowable tolerances, to the required section and established lines and grades. Allowable tolerances are set out in Section 321.

Prior to subsequent construction or release of maintenance, all irregularities, depressions, soft spots, and other deficiencies found by the Engineer shall be corrected to meet the requirements of these specifications without additional compensation.

After compaction and finishing, if the mixture contains plus No. 4 aggregate and the course is to serve as a base for bituminous pavement, at least one complete coverage shall be made with a steel wheel roller. The resulting surface shall be sprinkled as necessary to maintain the required moisture content and shall be thoroughly compacted and sealed with a pneumatic roller.

In addition to the requirements for density and correction of deficiencies, the Contractor shall be responsible for constructing and maintaining a course which will remain firm and stable under construction equipment and other traffic which the course will be subjected to prior to release of maintenance.

Compaction by vibration shall not be performed on any course or layer placed over a previously chemically treated course(s).

Density tests will be performed in accordance with the methods as provided in Subsections 700.03 and 700.04.

Determination of acceptance of compaction of granular courses for required density will be performed on a lot to lot basis. Each lot will be each 2,500 linear feet per layer placed. At the discretion of the Engineer, a residual portion of a lot

completed during a day's operation may be considered as a separate lot or may be included in the previous or the subsequent lot, except that any day's operation of less than one full lot will be considered a lot.

The lot will be divided into five approximately equal sublots with one density test taken at random in each sublot. The individual tests and the average of the five tests shall equal or exceed the values as shown in the table below.

Granular Material	Lot	Individual
<u>Class</u>	<u>Average</u>	<u>Test</u>
7,8,9 or 10	97.0	93.0
5 or 6	99.0	95.0
3 or 4	100.0	96.0
1 or 2	102.0	98.0
Crushed Stone Courses	99.0	95.0

When pavement is not required, the required density for the top course will be as shown in the table below.

Granular Material	Lot	Individual
<u>Class</u>	<u>Average</u>	<u>Test</u>
10	94.0	90.0
7,8 or 9	95.0	91.0
5 or 6	96.0	92.0
3 or 4	97.0	93.0
1 or 2	98.0	94.0
Crushed Stone Courses	96.0	92.0

No density tests will be required for granular or crushed stone courses used for temporary work such as maintaining temporary ramps and driveways.

A finished course shall be continually maintained until a subsequent course is placed thereon or the work is released from maintenance.

304.04--Method of Measurement. Granular material and crushed stone courses will be measured by the cubic yard, average end area (AEA) or LVM, or by the ton, as indicated in the bid schedule of the contract.

When the method of measurement is by the ton, measurement will be made on the dry unit weight basis. The moisture determination for computing the dry unit weight will be made in accordance with the methods as provided in Subsections 700.03 and 700.04 at least once a day and as many additional times as the Engineer deems necessary.

When the method of measurement is by the cubic yard average end area method (AEA), all calculations of areas for payment shall be based on computations

made to the nearest hundredth of a square foot from the typical sections shown on the plans. The length will be measured along the surface of the course at the centerline of each roadway or ramp. The theoretical volume calculated for payment will be to the neat lines as shown on the plans. The accepted quantity for payment will be the itemized proposal quantity as adjusted for authorized changes. The itemized proposal quantity will be corrected if it is shown to be in error by more than 2.0 percent.

Water necessary for processing granular material will not be measured for separate payment.

304.05--Basis of Payment. Granular material and crushed stone courses will be paid for at the contract unit price per unit specified in the bid schedule of the contract, which shall be full compensation for completing the work.

Payment will be made under:

- 304-A: Granular Material, LVM, Class____, Group____ - per cubic yard
- 304-B: Granular Material, Class____, Group____ - per ton
- 304-C: Granular Material, AEA, Class____, Group____ - per cubic yard
- 304-D: Granular Material, Size - per ton
- 304-E: Granular Material, LVM, Size - per cubic yard
- 304-F: Size Crushed Stone Base - per ton
- 304-G: Size Crushed Stone Base, AEA - per cubic yard
- 304-H: Size Crushed Stone Base, LVM - per cubic yard

SECTION 305 - IN-GRADE MODIFICATION

305.01--Description. This work consists of modifying in place materials by incorporating other materials and constructing one or more courses in accordance with these specifications and in reasonably close conformity with the lines, grades, and typical cross sections shown on the plans or established by the Engineer.

305.02--Materials.

305.02.1--Materials to be Modified. The materials to be modified shall consist of material in place on the roadbed or material placed under this contract or a

combination thereof.

General conditions governing the use of materials shall be as set out in Section 106.

305.02.2--Stabilizer Aggregates. Stabilizer aggregates of the kind and size specified shall meet the requirements of Subsection 703.20.

305.03--Construction Requirements.

305.03.1--Equipment. The methods and equipment used in performing the work shall meet the requirements of Subsection 108.05. Equipment necessary for proper prosecution of the work shall be on the project and approved by the Engineer prior to commencing work.

Watering equipment shall have pressurized spray bars with suitable nozzle openings.

Mixing and scarifying equipment shall have positive depth controls.

Rollers shall be of sufficient number, type, size, and weight to accomplish the required compaction.

When measurement for payment for stabilizer aggregate is to be made by the ton, the Contractor shall furnish approved platform scales capable of weighing the entire loaded vehicle. Scales and their use shall be in accordance with the requirements set out in Subsection 401.03.2.1.11, except they shall be installed at an approved location on or near the project.

305.03.2--Processing.

305.03.2.1--Before Addition of Stabilizer Aggregate. The material to be modified shall be prepared in accordance with the requirements of Section 321. In addition, if the existing surface consists of bituminous surfacing, the surfacing shall be scarified, pulverized, and thoroughly mixed until all the material will pass a three-inch sieve. The material shall then be brought to the designated lines, grades, and cross sections and to the required density.

To insure proper prosecution of the work, sufficient roadbed shall be prepared in advance of spreading stabilizer aggregate.

305.03.2.2--After Addition of Stabilizer Aggregate. After the roadbed and in place material have been prepared as specified and approved, the designated quantity of aggregate to be added shall be uniformly spread.

The Contractor shall organize the work so that delay in spreading and

incorporation of aggregate will be only for the time necessary to haul the required quantity of stabilizer materials on a section of sufficient length to permit a single effective spreading, mixing, shaping, and compacting operation. Dumping of long lines of stabilizer aggregates on the roadbed and prolonged periods of hauling adjacent thereto will not be permitted. Unless wet soil conditions prevent satisfactory manipulation, aggregates shall be incorporated not later than the following day.

Preliminary scarifying shall be carefully controlled, and the undisturbed foundation beneath the loose material shall have a crown conforming as nearly as practicable to that of the finished course.

Mixing shall immediately follow the proper distribution of the aggregate and shall be performed with rotary or other agitating type mixers, supplemented by other equipment as necessary to pulverize the materials and thoroughly incorporate each into the other so that the resulting course will be uniform throughout. During mixing, sufficient water shall be added to bring the material to the proper moisture content.

Mixing shall be carefully controlled to provide an undisturbed underlying foundation at the designed grade and cross section, and shall be continued until a minimum of 95.0 percent of all materials, exclusive of individual rocks or stone, will pass a two-inch sieve.

The first section of each modified course constructed will serve as a test section. The length of the test section shall be determined by the capabilities of the equipment selected to perform the work but will be at least 1000 feet and not more than 1500 feet for the designated width. The Contractor and Engineer will evaluate the results of the test section in relation to contract requirements. In case the Engineer determines the work does not comply with contract requirements, the Contractor's procedure and augment or equipment shall be revise as necessary to provide work completed in accordance with the contract and shall correct all deficient work at no additional cost to the State.

The Contractor shall be fully responsible for damage to or contamination of the underlying material or shoulder material and shall make corrections as necessary at no additional cost to the State.

For the purpose of determining reasonable conformity with the designated width of a course, the width of a course shall not vary from the designated edge lines by more than plus or minus three inches.

A course whose compacted thickness is designated to be more than eight inches shall be constructed in two or more layers of approximately equal thickness. The maximum compacted thickness of any one layer shall not exceed eight inches.

No material shall be placed on or mixed with frozen material.

305.03.3--Shaping, Compacting and Finishing. Compaction shall start longitudinally at the outer edges of the course and proceed toward the center. The material shall be sprinkled or aerated as necessary during compaction to maintain the needed moisture content for compaction.

Shaping and compacting shall be carried out in a manner that will prevent lamination and shall continue until the entire depth and width of the course has reached the required density. Throughout the entire compaction operation, the shape of the course shall be maintained by blading and rolling. Surface compaction and finishing shall be performed so as to produce a smooth, closely knit surface, free from lamination, cracks, ridges, or loose material, and conforming to the required section and established lines and grades.

Prior to subsequent construction or release of maintenance, all irregularities, depressions, soft spots, and other deficiencies shall be corrected to meet the requirements of these specifications without additional compensation.

Density tests will be performed in accordance with the methods as provided in Subsection 700.03 and 700.04.

Determination of acceptance of compaction of in-grade modification for required density will be performed on a lot to lot basis. Each lot will be 2,500 linear feet per layer placed. At the discretion of the Engineer, a residual portion of a lot completed during a day's operation may be considered as a separate lot or may be included in the previous or the subsequent lot, except that any day's operation of less than one full lot will be considered a lot.

The lot will be divided into five approximately equal sublots with one density test taken at random in each subplot. The average of the five density tests shall equal or exceed 93.0 percent with no single density test below 89.0 percent.

In addition to the requirements for density and correction of deficiencies, the Contractor shall be fully responsible for constructing and maintaining a course which will remain firm and stable under construction equipment and other traffic the course will be subjected to prior to release of maintenance.

The finished surface of a course shall conform to the requirements shown on the plans within the tolerances allowable under Section 321 and shall be maintained until covered by a subsequent course or the work is released from maintenance.

305.04--Method of Measurement. Processing for in-grade modification will be measured by the square yard, station, or mile, as designated.

Stabilizer aggregates of the type or size specified will be measured by the cubic

yard (LVM) or by the ton, as indicated in the bid schedule of the contract. No measurement for payment for water will be made.

When the method of measurement is by the ton, measurement will be made on the dry unit weight basis at the point of weighing. The moisture determination for computing the dry unit weight will be made in accordance with the methods set out in Subsection 700.03 at least once a day, and as many additional times as the Engineer deems necessary.

305.05--Basis of Payment. Processing for in-grade modification will be paid for at the contract unit price per unit specified. Stabilizer aggregate will be paid for at the contract unit price per unit specified, which price shall be full compensation for completing the work.

Payment will be made under:

305-A: Processing for In-Grade Modification	- per square yard, station or mile
305-B: Size ___ Stabilizer Aggregate, Coarse	- per cubic yard or ton
305-C: Stabilizer Aggregate, Shell	- per cubic yard or ton
305-D: Stabilizer Aggregate, Medium	- per cubic yard or ton
305-E: Stabilizer Aggregate, Fine	- per cubic yard or ton

SECTION 306 - ASPHALT DRAINAGE COURSE

306.01--Description. This work shall consist of the construction of a bituminous drainage course composed of a mixture of crushed aggregate and asphalt cement 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.

306.02--Materials.

306.02.1--Aggregates. The aggregate shall be a size no. 57 crushed limestone, sandstone or granite conforming to the quality requirements of Subsections 703.01, 703.02 and 703.03.

306.02.2--Bituminous Material. The bituminous material used in the mixture shall be petroleum asphalt cement, Grade PG 67-22, unless otherwise designated, meeting the requirements of Section 702.

306.02.3--Hydrated Lime. Hydrated lime shall meet the requirements of Subsection 714.03.2 for lime used in soil stabilization.

306.02.4--Composition of Mixes. The mixture shall be have an asphalt cement content of 2.5 percent by weight of total dry aggregate and production shall conform thereto within a production tolerance of plus or minus 0.4 percent. Hydrated lime shall be used at the rate of one percent (1%) by weight of the total dry aggregate.

The temperature of the completed mix shall be $235^{\circ} \pm 15^{\circ}\text{F}$.

306.03--Construction Requirements.

306.03.1--Weather Limitations. The asphalt drainage course shall not be placed on a wet or frozen surface, or when weather conditions will prevent proper handling, compacting or finishing of the mixture. No asphalt mixture shall be placed when either the surface or the air temperature is less than 40°F , as measured in the shade and away from any heat source.

306.03.2--Stockpiling. Aggregates shall be reclaimed from the stockpile so as to minimize segregation. Aggregates that have been mixed with earth or foreign material, or become coated with undesirable material shall not be used.

306.03.3--Asphalt Mixing Plant. The asphalt mixing plant for asphalt drainage course shall conform to the requirements of Subsection 401.03.2.

306.03.4--Blank.

306.03.5--Blank.

306.03.6--Hauling Equipment. Hauling equipment shall conform to the requirements of Subsection 401.03.3.

306.03.7--Spreading Equipment. The asphalt mixture shall be spread with a bituminous paver meeting the requirements of Subsection 401.03.4.

306.03.8--Rollers. Rollers shall conform to Subsection 401.03.5 with the following exceptions:

- (a) Pneumatic-tired rollers shall not be used.
- (b) Rollers shall not weigh less than eight (8) tons nor more than 12 tons.
- (c) Vibratory rollers, if used, shall only be operated in the static mode.

306.03.9--Spreading and Finishing. Asphalt drainage course mixture shall be deposited and spread on an approved surface. On areas where irregularities or unavoidable obstacles preclude spreading by mechanical equipment, the mixture

shall be deposited, spread, raked and luted by hand tools.

Unless otherwise noted, the asphalt drainage course shall be spread and compacted in one layer to a 4-inch thickness.

306.03.10--Compaction. Compaction shall consist of rolling by vibratory rollers operated in the static mode or steel-wheeled tandem rollers. Compaction shall be achieved by the application of 1 to 3 complete roller coverages with a steel-wheel, two-axle tandem roller weighing not less than eight (8) tons nor more than 12 tons, as directed by the Engineer. Compaction shall not begin until the temperature of the mixture has cooled to less than 150° F and shall be completed before the mixture is less than 100°F. Asphalt drainage course shall not be cooled with water.

306.03.11--Surface Tolerance. The surface, excluding shoulders, will be tested after final rolling at selected locations using a 10-foot straightedge. The variation of the surface between any two contacts with the surface shall not exceed 3/8 of an inch. All bumps or depressions exceeding this requirement shall be corrected by removing defective work and replacing with new material as directed at no additional cost to the State. All areas requiring removal and replacement shall meet the above surface tolerance.

306.03.12--Thickness Requirements. The maximum allowable deficiency shall be 3/8 of an inch. When the thickness deficiency exceeds 3/8 of an inch, the Contractor shall remove the deficient material and replace at no additional cost to the State.

When stringline grade controls are eliminated for the placement of the asphalt drainage course, the thickness shall be determined by cores taken from the completed pavement in accordance with Subsection 403.03.3. When the thickness deficiency exceeds 3/8 of an inch, payment will be made on a pro rata basis of the required thickness.

Example based on a 4-inch required thickness:

Measured thickness = 3.0"
Minimum allowable thickness = 3.625" (3 5/8")

Payment = $\frac{3.0}{3.625}$ = Eighty-three percent (83%) of the bid item price

306.03.13--Construction Traffic and Equipment Restriction. Construction traffic and equipment operating on the completed asphalt drainage course shall be restricted to only that directly involved in placement of the pavement layer on the asphalt drainage course. The asphalt drainage course shall not be used as a haul road for delivery of materials. Trucks delivering paving materials shall enter immediately in front of the paver and after emptying, shall depart

immediately therefrom. Twisting and turning traffic shall not be allowed. The Contractor shall protect the asphalt drainage course from becoming clogged with dirt or foreign materials resulting from the operation of construction traffic and equipment. Damage to asphalt drainage course by construction traffic and equipment shall be corrected through repair or replacement of the damaged area at no additional cost to the State.

306.04--Method of Measurement. Asphalt drainage course will be measured by the square yard. Measurement will be determined by multiplying the width of the drainage course by the length of the drainage course. The width for measurement will be the plan width, including widening where called for, or as otherwise authorized by the Engineer. The length will be measured horizontally in accordance with Section 109.

306.05--Basis of Payment. Asphalt drainage course, measured as prescribed above, will be paid for at the contract unit price per square yard and shall be full compensation for furnishing all labor, equipment, materials, tools, and supplies and for all other costs including producing, screening, loading, hauling, stockpiling the asphalt drainage course aggregate, furnishing the asphalt cement, mixing, spreading, compacting the asphalt drainage course, and all other work necessary for the construction of the asphalt drainage course.

Payment will be made under:

306-A: Asphalt Drainage Course

- per square yard

SECTION 307 - LIME TREATED COURSES

307.01--Description. This work consists of constructing one or more courses of a mixture of soil, hydrated lime and water, or a mixture of soil and hydrated lime slurry in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer. When lime slurry is used the Contractor shall mix hydrated lime with water to produce lime slurry or, at the Contractor's option, produce lime slurry at the job site by the use of equipment specifically manufactured for the slaking of quick lime.

The use of quick lime by the dry application method will not be allowed unless the lime meets the requirements of Subsection 714.03.3.2 for Dry Quick Lime.

The work shall include preparation of the roadbed, incorporation of lime or lime slurry, and processing to the proper grade, section and density in accordance with one of the following methods:

Class A lime treatment shall consist of spreading and incorporating the

specified percentage of lime in two increments in the following sequence: spreading the first increment, initial mixing, mellowing, spreading the second increment, final mixing, compacting, and finishing.

Class B lime treatment shall consist of spreading the specified percentage of lime, initial mixing, mellowing, final mixing, compacting, and finishing.

Class C lime treatment shall consist of spreading the specified percentage of lime, mixing, compacting, and finishing.

Occasionally, the scheduling of contract lettings results in advertising a project before the final soil profile is available, and it is not possible to determine, prior to advertising, the precise class of lime treatment required. Design considerations, therefore, sometimes necessitate changing the class(es) of lime treatment in order to obtain the contemplated structural qualities without unnecessary cost.

The Department reserves the right to modify by Supplemental Agreement or Quantity Adjustment the class of treatment or to eliminate lime treatment from certain sections or to add other sections for lime treatment depending on the results of soil tests.

307.02--Materials.

307.02.1--Materials to be Treated. The material to be treated shall consist of existing roadbed material or material added as directed. Particles of aggregate retained on a three-inch sieve and deleterious substances such as roots, stumps, grass turfs, and other vegetable matter shall be removed from the soil. Material considered by the Engineer to be unsuitable for stabilization shall be removed and replaced with suitable material.

307.02.2--Water. Water used in this construction shall meet the requirements of Subsection 714.01.3.

307.02.3--Lime. Lime shall be either a commercial dry hydrated lime or a commercial dry, granular or pelletized quick lime meeting the applicable requirements of Subsection 714.03. When bulk lime is used, the Contractor shall provide means suitable to the Engineer for applying. The Engineer shall weigh shipments at random for verification of bulk lime quantities.

307.02.4--Curing Seals. Curing seal shall be Emulsified Asphalt, Grade EA-1, SS-1, CMS-2h, or MS-2h meeting the applicable requirements of Section 702.

307.02.5--Soil-Lime Design. The design of soil-lime courses shall be performed by the MDOT Central Laboratory.

307.03--Construction Requirements.

307.03.1--General. Quantities and percentages of lime shown on the plans and in the proposal are based on preliminary soil investigations and dry laboratory sample tests. The actual application rates will be established from tests made just prior to beginning treatment. The Contractor is advised that the estimated quantity of lime is based on application rates of hydrated lime.

It is necessary that lime treated materials be kept moist at all times. It shall be the Contractor's responsibility to provide sufficient equipment and keep all partially constructed or completed lime stabilized layers sufficiently and continually moist until a succeeding layer has been placed thereon or until the project is released from maintenance.

The first section of each mixing operation, both initial and final, will serve as a test section. The length of the test section will be determined by the capabilities of the equipment provided to perform the work, but not less than 350 linear feet nor more than 500 linear feet for the designated width. The Engineer and the Contractor will evaluate the results of the test section in relation to contract requirements. In case the Engineer determines the work is not satisfactory, the Contractor's procedures shall be revised and augment or replace equipment as necessary to assure work is completed in accordance with the contract and shall correct all deficient work at no additional cost to the State.

Also within the test section and only when the dry-application method of quicklime is used, a sample of the soil-lime-water mixture shall be taken after the completion of the mixing operation. This sample shall be taken, by the Contractor, to an independent testing laboratory to determine, using the X-ray Diffraction Test or the Titration Analysis Test, the percent of hydration. After the completion of the test section, the Contractor shall not continue operations until the results of the test sample have been determined. The Contractor shall provide the Engineer with three copies of a certified test report showing that the non-hydrated content of the sample has not exceeded one percent (1.0%) of the total mix. Should the sample not meet the hydration requirements, the Contractor shall re-mix the section and add sufficient water until satisfactory results are achieved. All testing costs associated with determining the hydration efficiency of the sample(s) will be at no additional cost to the State. MDOT reserves the right to make hydration verification checks of the soil-lime-water mixture at any time.

307.03.2--Equipment. The methods and equipment used in performing the work shall conform to the requirements of Subsection 108.05. Equipment necessary for proper prosecution of the work shall be on the project and approved by the Engineer prior to its use.

When bulk lime is used and application of lime is made from equipment other than the delivery transport, batch-type or platform scales meeting the requirements of Subsection 401.03.2.1.11, respectively, shall be provided at

approved locations on or near the project.

When bulk lime is used, the Contractor shall provide approved mechanical spreader(s) having adjustable strike-off gate(s), or other approved spreading equipment constructed so as to provide positive control of the spread. Approval of a spreader will be contingent upon its known or demonstrated ability to make distribution of lime within the tolerances allowable.

Mixing and scarifying equipment shall be capable of positive depth control. Mixing shall be performed with approved rotary-type mixers or other approved equipment.

Rollers shall be of sufficient number, type, size, and weight to accomplish the required compaction.

The Contractor may use approved alternate equipment provided it produces work meeting the requirements of these specifications.

307.03.3--Preparation of Grade. Before treatment, the roadbed shall be prepared in accordance with the requirements of Section 321.

Prior to the application of dry hydrated lime, a light windrow shall be bladed along the edges of the area to be treated, or the surface on which the lime is to be applied shall be scarified to retain the spread.

Prior to the application of slurry, the full width of the area shall be scarified or partially pulverized to the depth necessary to retain the lime slurry until it has been incorporated.

The depth of scarification shall be carefully controlled so that the surface of the roadbed below the scarified material will remain undisturbed and conform to the established cross section.

307.03.4--Application of Lime. The rate of application of lime shall be as specified. The first application for Class A treatment shall not be made after October 15, and no lime shall be applied between November 1 and March 1 without written authorization from the Engineer.

Lime shall not be applied unless the temperature in the shade is at least 40°F and is expected to remain at least 40°F during the mixing period. In no case shall lime be applied on a frozen foundation.

Application of lime shall be accomplished by either an approved "dry application" or "slurry application" method.

The following guide lines will govern the acceptability of the method to be used:

Dry Application. Lime applied by this method shall be spread uniformly and shall be sprinkled with sufficient water to prevent loss of lime by wind. Spreading of lime when wind and weather conditions are unfavorable will not be permitted nor will spreading of lime by motor patrol be acceptable.

The Department reserves the right to check, at any time, the dispersion of quick lime dust in the atmosphere. At no time shall the atmosphere dispersion of quick lime dust exceed a rate of $30,000 \mu\text{g}/\text{m}^3$, measured at a distance of 100 feet.

Slurry Application. Lime applied by this method shall be mixed with water in approved agitation equipment and applied to the roadbed as a thin water suspension or slurry. The distributing equipment shall be equipped to provide continuous agitation of the slurry until applied on the roadbed. The proportion of lime shall be such that the "Dry Solids Content" shall be at least 30 percent by weight.

The distribution of lime at the rate specified shall be attained by one or more passes over a measured section until the specified percentage of lime has been spread. After each successive pass the material shall be incorporated into the soil with the mixing equipment. Additional water, if necessary, shall be added and mixed into the mass to hasten mellowing.

Payment will not be made for lime that has been spread and exposed for a period of six hours or more before mixing. Such areas shall be treated again with the full required rate of application.

Additional lime shall be added at the Contractor's expense to any section on which excessive lime loss has occurred due to washing or blowing, prior to mixing.

The quantity of lime applied on a section shall be spread uniformly and shall not vary more than plus or minus five percent of the quantity ordered. No payment will be made for lime application exceeding the five percent plus tolerance. When the quantity applied is deficient by more than five percent, additional lime shall be applied prior to mixing.

307.03.5--Mixing.

307.03.5.1--Initial Mixing. For Class A and Class B treatments, the lime and water shall be incorporated uniformly into the soil. The mixing and watering operation shall be continued until a homogeneous mixture that will pass a three-inch sieve is obtained. After satisfactory mixing is obtained, the layer shall be reshaped to line, grade, and section and sealed with a light roller no later than the next day following mixing. The sealed mixture shall then mellow for the period specified in the lime mix design furnished by the Central Laboratory. The

mellowing period will be measured in degree days. This period will not be less than five (5) nor more than 20 calendar days. The temperature to be used to determine the degree days mellowing period will be the average of the high and low temperatures for each day of the mellowing period. In the event the average is 40°F or less, that day will not be used in computing the degree days mellowing period. The recommended degree days for the mellowing period may be reduced by the Engineer provided pulverization during final mixing is documented by sieve analysis.

During the mellowing period the partially treated course or layer shall be kept moist by sprinkling. All sections on which the surface becomes dry during the mellowing period shall be reprocessed to the satisfaction of the Engineer or reconstructed in accordance with these specifications.

For Class C treatment, the lime and water shall be incorporated uniformly into the soil. The mixing and water application shall be continued until a homogeneous mixture of which 100 percent of the material by dry weight, exclusive of gravel and stone, will pass a 1-inch sieve and 60 percent will pass a No. 4 sieve. At the completion of moist mixing and during the compaction operations, the percentage of moisture shall be that necessary to obtain the required density. No mellowing period will be required or permitted, and compaction shall begin immediately. The mixing, water application, and final compaction shall be completed during the same work day.

307.03.5.2--Final Mixing. After the mellowing period of Classes A and B treatments, the layer shall be scarified and, in the case of Class A treatment, the second application of lime added. The layer shall then be remixed as prescribed in the initial mixing operations. Mixing shall continue until 100 percent of material by dry weight, exclusive of gravel and stone, will pass a 1-inch sieve and 60 percent will pass a No. 4 sieve. At the end of mixing and during compaction, the moisture in the mixture shall be that necessary to obtain the required density.

307.03.5.3--Thickness and Width Requirements. For the purpose of determining reasonable conformity with the designated thickness of a course, it shall be understood that the depth of a course shall not vary from the designated thickness by more than plus or minus one inch. All sections not in reasonably close conformity because of deficient thickness shall be reprocessed to meet specification requirements. All sections not in reasonably close conformity because of excess thickness shall have additional lime applied and shall be reprocessed to meet specification requirements at no additional cost to the State.

For the purpose of determining reasonable conformity with the designated width of a course, it shall be understood that the width of a course shall not vary from the designated edge lines by more than plus or minus three inches.

307.03.6--Compaction. Compaction of the mixture shall begin immediately after the required mixing operation has been completed.

Compaction shall be completed during same day it was begun and shall provide uniform and continuous compaction from bottom to top of the layer. The mixture shall be aerated or watered as necessary to provide the needed moisture content for obtaining the required density.

Throughout the entire compaction operation, depressions, defective areas, and soft spots which develop shall be corrected immediately by scarifying the area, adding lime when required, or removing the material, and reshaping and compacting in accordance with these specifications at no additional cost to the State.

Density tests will be performed in accordance with the methods as provided in Subsections 700.03 and 700.04.

Determination of acceptance of compaction of Classes A, B, and C lime treated design soil will be performed on a lot to lot basis. Each lot will be 2,500 linear feet per layer placed. At the discretion of the Engineer, a residual portion of a lot completed during a day's operation may be considered as a separate lot or may be included in the previous or subsequent lot, except that any day's operation of less than one full lot will be considered a lot.

The lot will be divided into five approximately equal sublots with one density test taken at random in each subplot . The average of the five density tests shall equal or exceed 95.0 percent with no single density test below 91.0 percent. Sublots with a density below 91.0 percent shall be corrected at no additional cost to the State and retested for acceptance.

307.03.7--Finishing, Curing, Protection, and Maintaining. The surface of the layer shall be smooth and conform to the lines, grades, and typical cross sections shown on the plans or established by the Engineer. Surface requirements shall be as specified in Subsection 321.03.7.

Each complete course shall be covered with a bituminous curing seal as soon as possible but no later than 24 hours after completion. The surface shall be sealed with one of the specified bituminous materials applied by a pressure distributor at the rate of 0.10 to 0.25 gallon per square yard or as directed by the Engineer. The bituminous material shall be heated or otherwise prepared to insure uniform distribution. Should the Contractor fail to seal the lime-fly ash course within the time specified, the Engineer will suspend all other work and withhold payment of the current estimate(s) until all damages resulting there from is corrected and the treated course is sealed.

A subsequent course shall not be placed on the sealed course for at least seven

(7) calendar days. During this 7-day period, the treated course shall not be subjected to any type of traffic and equipment.

The Contractor shall maintain the treated course and the curing seal in a satisfactory condition until covered by a subsequent course. Protection shall include immediate repairs of any surface irregularities or other defects that may occur or develop. It shall be the Contractor's responsibility to control traffic and equipment loads to avoid damage and to guard against freezing of the treated material.

All damage resulting from the Contractor's failure to protect and cure the treated course as specified herein or from freezing that may occur prior to being covered with the next course shall be corrected at no additional cost to the State.

Lime treated courses shall be corrected by reprocessing with Class C treatment to such depth as necessary to restore the CBR (California Bearing Ratio) of the damaged material to that shown on the mix design, all at no additional cost to the State. The Contractor shall add the necessary quantity of lime, as determined by the Central Laboratory, and in no case shall it be less than two percent by weight.

307.04--Method of Measurement. Soil-lime-water mixing will be measured by the square yard, complete in place, for each course designated on the plans and for which quantities have been included in the contract.

If a change in the class of treatment is made, as provided in Subsection 307.01, each class of treatment constructed will be measured separately.

Lime incorporated in accepted treatment will be measured by the ton. Lime in excess of the tolerance allowable and all lime required to be furnished by the Contractor at no additional cost to the State will be deducted from measured quantities.

The basis of pay for jobsite slaked lime slurry shall be the "calculated method" using the certified lime purity for each truckload as follows:

$$\text{Pure Quick Lime (Ca O)} \times 1.32 = \text{Hydrated Lime (Ca (OH)}_2\text{)}$$

$$\text{Quick Lime delivered} \times \% \text{ purity} \times 1.32 = A$$

$$\text{Quick Lime delivered} \times \% \text{ inert material} \times 1.0 = B$$

$$A + B = \text{Total Hydrated Lime produced (Pay Quantity)}$$

The basis of pay for quick lime by the dry application method shall be the "calculated method" using the certified lime purity for each truckload as follows:

Pure Quick Lime (Ca O) x 1.32 = Hydrated Lime (Ca (OH)₂)

Quick Lime delivered x % purity X 1.32 = A

QUICK LIME DELIVERED X % INERT MATERIAL X 1.0 = B

A + B = Total Hydrated Lime produced (Pay Quantity)

Water and curing seal will not be measured for separate payment.

307.05--Basis of Payment. Soil-lime-water mixing and lime, measured as provided above, will be paid for as follows:

Soil-lime-water mixing of the class(es) specified or ordered will be paid for at the contract unit price, or adjusted unit price as provided herein, per square yard.

Quantities of soil-lime-water mixing changed as ordered will be paid for at the contract unit price for soil-lime-water mixing plus or minus, as applicable, the amount indicated in the following schedule:

SCHEDULE FOR 6" DEPTH⁽¹⁾

<u>Class Ordered</u>	<u>Unit Price Per Square Yard</u>
A	Class B Unit Price Bid Plus \$0.05
A	Class C Unit Price Bid Plus \$0.10
B	Class A Unit Price Bid Minus \$0.05
B	Class C Unit Price Bid Plus \$0.05
C	Class A Unit Price Bid Minus \$0.10
C	Class B Unit Price Bid Minus \$0.05

SCHEDULE FOR 8" DEPTH⁽¹⁾

<u>Class Ordered</u>	<u>Unit Price Per Square Yard</u>
A	Class B Unit Price Bid Plus \$0.10
A	Class C Unit Price Bid Plus \$0.15
B	Class A Unit Price Bid Minus \$0.10
B	Class C Unit Price Bid Plus \$0.05
C	Class A Unit Price Bid Minus \$0.15
C	Class B Unit Price Bid Minus \$0.05

SCHEDULE FOR 10" DEPTH⁽¹⁾

<u>Class Ordered</u>	<u>Unit Price Per Square Yard</u>
A	Class 'B' unit price bid plus \$0.15
A	Class 'C' unit price bid plus \$0.20
B	Class 'A' unit price bid minus \$0.15
B	Class 'C' unit price bid plus \$0.05
C	Class 'A' unit price bid minus \$0.20
C	Class 'B' unit price bid minus \$0.05

(1) When the Schedule and classes bid in the contract result in two unit prices for an ordered class, the smaller of the two is to be used as the established unit price.

Lime will be paid for at the contract unit price per ton.

Payment for removal and disposal of unsuitable material will be made under other provisions of the contract.

The prices thus paid shall be full compensation for completing the work.

Payment will be made under:

- 307-A: ____ " Soil-Lime-Water Mixing, Class A - per square yard
- 307-B: ____ " Soil-Lime-Water Mixing, Class B - per square yard

307-C: ____" Soil-Lime-Water Mixing, Class C

- per square yard

307-D: Lime

- per ton

SECTION 308 - PORTLAND CEMENT TREATED COURSES

308.01--Description. This work consists of constructing one or more courses of a mixture of cement, soil or soil aggregate, and water in accordance with these specifications and in reasonably close conformity with the lines, grades, and typical cross sections shown on the plans or established by the Engineer.

308.02--Materials.

308.02.1--Materials to be Treated. The materials to be treated shall consist of materials in place or placed under this contract.

308.02.2--Water. Water shall conform to the requirements of Subsection 714.01.3.

308.02.3--Portland Cement. Cement shall conform to the requirements of Section 701.

When bulk cement is used, the Contractor shall provide means suitable to the Engineer for applying. The Engineer shall weigh shipments at random for verification of bulk cement quantities.

When bag cement is furnished, the bag shall bear the manufacturer's certified weight. Bags varying more than five percent from the certified weight will be rejected, and the average weight of bags in any shipment, determined by weighing 50 bags taken at random, shall not be less than the certified weight.

Cement shall be stored and handled in closed, weatherproof containers until distribution to the section of road being processed. If storage bins are used, they shall be completely enclosed.

308.02.4--Curing Seals. Curing seal shall be Emulsified Asphalt, Grade EA-1, SS-1, CMS-2h, or MS-2h meeting the applicable requirements of Section 702.

308.02.5--Soil-Cement Design. The design of soil-cement courses shall be performed by the Central Laboratory.

308.03--Construction Requirements.

308.03.1--General. The intent of these specifications is to provide for a cement treated course of designated thickness consisting of a uniform mixture of cement,

soil or soil aggregate, and water; constructed at the required moisture content to the required density; free of laminations, construction cracks, ridges, or loose material; and with a smooth, closely knit surface meeting the requirements set out in Section 321.

A course whose compacted thickness is designated to be more than eight inches, shall be constructed in two or more layers of approximately equal thickness. The maximum compacted thickness of any one layer shall not exceed eight inches.

Immediately prior to placement of a course to be cement treated on an in place cement treated course, the in place course shall be thoroughly moistened.

Except as necessary to provide the required curing and maintenance of traffic, all equipment and traffic shall be kept off each completed cement treated course until it is thoroughly cured. Unless otherwise specified, the curing period shall be seven days exclusive of days during which the temperature falls below 35°F.

Prior to joining a previous day's work, or work more than two hours old, a vertical construction joint, normal to the centerline of the roadbed, shall be made in the old work. The joint shall be moistened if dry. Additional processing shall not be started until the construction joint has been approved by the Engineer.

When vertical longitudinal joints are specified or permitted, the joints shall be constructed parallel to the centerline by cutting into the existing edge for a sufficient distance to provide a vertical face for the depth of the course. The material cut away may be disposed of by spreading in a thin layer on the adjacent lane to be constructed, or otherwise disposed of in a satisfactory manner. If dry, cut joints shall be moistened immediately in advance of placing fresh mixture adjacent to them.

On multi-lane construction, the Contractor may construct temporary crossovers at locations approved by the Engineer between roadway lanes to facilitate construction operations. The crossovers shall be built, removed, the median restored to section, and all erosion control items completed in accordance with the requirements of the specifications without extra cost to the State.

The first section of each cement treated course constructed will serve as a test section. The length of the test section will be determined by the capability of the equipment provided to perform the work, but not less than 350 linear feet nor more than 500 linear feet for the designated width. The Engineer and the Contractor will evaluate results of the test section in relation to contract requirements. In case the Engineer determines the work is not satisfactory, the Contractor's procedures shall be revised and augment or replace equipment as necessary to assure work completed in accordance with the contract, and shall correct all deficient work at no additional cost to the State.

308.03.2--Equipment.

308.03.2.1--General. Equipment necessary for the proper prosecution of the work shall be on the project and approved by the Engineer prior to its use.

When bulk cement is used and application of cement is made from equipment other than the delivery transport, batch-type or platform scales meeting the requirements of Subsection 401.03.2.1.11, respectively, shall be provided at approved locations on or near the project.

Approval of cement spreaders will be contingent upon their known or demonstrated ability to make distribution of cement within allowable tolerances.

Watering equipment shall be pressurized, have one or more spray bars with suitable nozzle openings, and have positive controls for applying varying quantities of water.

Mixing shall be performed with multiple pass mixers, single pass mixers, traveling mixing plants, or central mixing plants, as specified in the contract.

Mixing and scarifying equipment for the road mix methods shall be capable of positive depth control.

Rollers shall be of sufficient number, type, size, and weight to accomplish the required compaction.

Leakage of water, oil, grease, or other liquids from equipment shall be immediately corrected, or the leaking equipment removed from the work and replaced with satisfactory equipment.

308.03.2.2--Multiple Pass Mixers. Multiple pass mixers shall be the rotary-type with sufficient tines and so constructed and operable as to obtain by multiple passes uniform mixture of the cement, soil-aggregate, and water for the full depth of the course.

308.03.2.3--Single Pass Mixers. Single pass mixers shall be the pugmill type so constructed and operable as to meter the required quantity of water through a pressurized spray and obtain by a single pass a uniform mixture of the cement, soil or soil-aggregate, and water for the full depth of the course.

308.03.2.4--Traveling Plant Mixers. Traveling mixing plants shall be either of the type which will pulverize the material to be treated and mix it and cement with the proper quantity of water without picking the materials up from the roadway, or of the pugmill type which elevates the materials into a pugmill for mixing. The plant shall be equipped with a device which will accurately control and measure the quantity of water used. Worn scarifying and mixing parts shall

be replaced, and extra parts shall be available for replacements.

308.03.2.5--Central Plant Mixers. Central mixing plants shall be either the batch type using revolving blade or rotary drum mixers or the continuous mixing type. The cement, soil or soil-aggregate, and water may be proportioned either by weight or by volume. There shall be means by which the Engineer can readily verify the proportions in each batch or the rate of flow for continuous mixing.

The charge and mixing time in a batch mixer, or the rate of feed to a continuous mixer, shall be such as to obtain complete mixing of all the material. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected. The plant shall deliver a uniform mixture meeting all specified requirements.

308.03.3--Road Mix Method. When the road mix method is used, no hauling of materials for a subsequent course will be permitted directly on a completed cement treated course. Placing of material for a higher course shall be accomplished as outlined in Subsection 321.03. Materials for a higher course shall be kept bladed down as it is placed, and hauled over with truck traffic being distributed over its entire width.

Where reconstruction is required, it shall be for the full depth and width of the deficient section. The adding of a thin layer or strip of cement treated material will not be permitted. All sections to be reconstructed later than the two-hour period allowed for initial compaction shall have additional cement. When reconstruction is to be performed within 48 hours after the initial application of cement, 50 percent of the original quantity of cement shall be added. When reconstruction is to be later than 48 hours after the initial application of cement, an engineering study will be made, and the Engineer will specify the additional quantity of cement to be added, or the Engineer may require the total removal of the deficient work. If removal is required, a course meeting the requirements of the contract shall be constructed with new materials.

In all cases where reconstruction is performed by the addition of cement, the cement, in place materials, and water shall be thoroughly mixed, processed, compacted, and finished in accordance with the requirements of the contract.

Where deficient work is removed, the removal and disposal shall be performed in a manner satisfactory to the Engineer, and all materials shall be replaced and a new course constructed in accordance with the requirements of the contract. The furnishing of all materials for and all reconstruction shall be performed by the Contractor at no additional cost to the State.

308.03.4--Central Plant Mix Method. When the central plant mix method is used, material for a higher course may be hauled directly on a completed and

properly cured cement treated course for the minimum distance necessary as referenced in Subsection 321.03. The Contractor shall be fully responsible for all damages to the course.

Prior to placement of a course processed by the plant mix method, the Contractor shall have made satisfactory provisions for completing the section to specified requirements. To comply with these requirements, the Contractor shall, if necessary, use material(s) specified for contiguous shoulder construction.

The mixture shall be hauled to the roadway in trucks equipped with protective covers. The mixture shall be uniformly placed on a moistened foundation by full-width spreader, or partial-width spreaders working in echelon and spaced close enough together to place the entire course in one operation. The elapsed time between the start of moist mixing and the start of compaction on the roadway shall not exceed 60 minutes. The elapsed time between placement of cement treated material in adjacent lanes shall not exceed 30 minutes, except where longitudinal construction joints are specified, or when joints are permitted by the Engineer in case of emergency. In the latter case longitudinal joints conforming to the requirements of these specifications will be permitted only to allow placement of material in transit at the time of the emergency.

The material shall be placed, shaped, and compacted so that the completed course will be uniform, smooth, and conform to all of the requirements specified.

Dumping of the mixture in piles or windrows and spreading with a motor grader or similar equipment will not be permitted except where the Engineer determines that such spreading is reasonable, as in the case of small areas inaccessible to mechanical spreaders.

In all cases where reconstruction is required, the deficient work shall be removed, disposed of, and replaced with materials meeting the requirements of these specifications. Reconstruction shall be for the full depth and width of the deficient section, except where the Engineer determines that partial reconstruction will be sufficient, the Engineer may authorize in writing that reconstruction may be made on the defined partial section in accordance with the provisions and requirements for reconstruction under Subsection 308.03.3 at no additional cost to the State.

308.03.5--Preparation of Grade. Prior to construction or reconstruction, the foundation shall be prepared in accordance with the requirements of Section 321. The tolerance from design grade immediately prior to spreading cement shall be minus one inch for design soils and plus or minus one-half inch for bases.

308.03.6--Preparation of Materials. Particles of aggregates larger than those passing a three-inch sieve and deleterious substances, such as roots, sticks, grass turfs, or other vegetable matter shall be removed.

308.03.7--Application of Cement.

308.03.7.1--General. The percentages of cement shown on the plans are based on preliminary soil investigation and are approximate. Before construction is started, the Department will make the necessary tests to determine the percentages of cement required.

The quantity of cement spread on a section or added through a central plant shall not vary more than five percent of the quantity ordered. When the quantity spread is deficient by more than five percent, an additional application of cement shall be uniformly spread over the entire section to correct the deficiency prior to mixing operation. Cement, including that applied to correct deficiency, in excess of the allowable plus tolerance will be deducted from measured quantities.

When the quantity of cement added through a central plant is deficient by more than the allowable tolerance, all mixtures produced with deficient cement will be considered unacceptable.

When the quantity of cement added through a central plant is in excess of the allowable tolerance, the excess will be computed by the Engineer and deducted from measured quantities.

308.03.7.2--Weather Limitations. No cement or cement treated material shall be placed in Districts 1, 2, 3, and 5 between November 15 and March 15, nor in Districts 6 and 7 between December 1 and March 1. Cement or cement treated material shall not be applied when the temperature is below 40°F nor when the Engineer determines, based on the latest information available from the National Weather Service, that probable freezing will occur within seven days in the area in which the project is located. No cement or cement treated material shall be placed on a frozen foundation, nor shall cement be mixed with frozen material.

308.03.7.3--Road Mix Method. After preparation of the grade, the required quantity of cement shall be spread uniformly over the grade. Cement lost or damaged from any cause shall be replaced without additional compensation before mixing is started.

The cement spreader shall be positioned by string lines or other approved methods during spreading to insure proper application of cement. All cement deposited into the spreader shall be weighed so that the pay quantity and the rate of spread can be determined.

In small areas, bag distribution in an approved manner, will be permitted. When bag distribution is made, a spike-toothed harrow or other equipment, which will not drag or blade the cement out of desired position but will strike it off at a uniform height, may be used. A motor grader, or other blade-type equipment, shall not be used to spread the cement.

Except for final finishing, all processing shall be completed within three hours after spreading. Except by written permission of the Engineer, no cement shall be spread on an area which cannot be completely processed, including all final surface finishing, during the same day.

No cement shall be applied when the moisture content of the material to be processed exceeds the optimum for the soil-cement mixture by more than two percentage points. No cement shall be spread when free water is on the surface of the roadbed.

No equipment except that used in spreading or mixing shall be allowed to pass over the freshly spread cement until mixed with the material to be treated.

308.03.7.4--Central Plant Mix Method. The cement shall be uniformly metered into the soil or soil-aggregate in the specified proportions and at the time and in the manner that the application of water will not cause formation of cement balls.

308.03.8--Mixing.

308.03.8.1--General. Unless otherwise indicated, cement treated materials may be processed by any one or combination of the mixing equipment described in Subsection 308.03.2. Where the bid schedule indicates single pass mixers, traveling plant mixers or central plant mixers will also be permitted. Where the bid schedule indicates traveling plant mixers, central plant mixers will also be permitted.

Preliminary scarifying shall be carefully controlled and the undisturbed foundation shall have a crown conforming as nearly as practicable to that of the finished course. Subject to the moisture limitations prior to spreading cement as referenced in Subsection 308.03.7.3, soil to be processed may be pre-wet prior to spreading cement. All additional water required to bring the section being processed to the required moisture content shall be applied within one hour after the beginning of mixing.

Mixing shall be carefully controlled so that the bottom of the course will conform as closely as possible to the design grade and cross section.

When the plans indicate multiple courses to be constructed, the material for each course shall be mixed separately. Multiple courses shall be constructed so that each course is in direct contact with the underlying course, and an unmixed cushion of material between layers will not be permitted.

Each increment of water added during mixing shall be incorporated into the mixture for the full depth, and no portion of the mixture shall remain undisturbed for more than 30 minutes prior to compaction. Mixing and water application

shall be continued as necessary to produce a completed mixture of uniform moisture content. Particular care shall be exercised to insure satisfactory moisture distribution along the edges of the section, and to avoid the addition of excess water.

The soil-cement mixture for subgrade and base construction shall be pulverized to the extent that 100 percent of the material, exclusive of gravel and stone, by dry weight will pass a 1-inch sieve and a minimum of 75 percent will pass a No. 4 sieve.

The soil-cement mixture for design soils shall be pulverized to the extent that 100 percent of the material, exclusive of gravel and stone, by dry weight will pass a 1-inch sieve and a minimum of 60 percent will pass No. 4 sieve.

When the un-compacted mixture is wetted by rain to the extent the average moisture content at the time for final compaction exceeds optimum by more than two percent, or if any of the operations after the start of mixing are interrupted continuously for more than 30 minutes, the entire area affected shall be reconstructed in accordance with these specifications at no additional cost to the State.

308.03.8.2--Road Mix Methods.

308.03.8.2.1--Multiple Pass Mixing. After the cement has been spread, it shall be mixed with the material to be treated without the addition of water. Immediately after the preliminary mixing of cement and soil or soil-aggregate, water as necessary shall be applied in the quantity required and incorporated uniformly into the mixture for the full depth.

After the last increment of water has been applied, mixing shall continue as necessary until a uniform mixture of cement, soil or soil-aggregate, and water for the full depth of the course has been obtained.

308.03.8.2.2--Single Pass Mixing. After the cement has been spread, it shall be mixed by a mixer which applies water and mixes in one simultaneous and continuous operation. The mixer shall be operated at a speed that will produce a uniform mixture meeting all specified requirements for the full depth of the course.

308.03.8.2.3--Traveling Plant Mixing. After the cement has been spread, it shall be mixed with a traveling plant mixer that will apply the proper quantity of water and produce in one simultaneous and continuous operation a mixture meeting all the requirements of the contract.

308.03.8.3--Central Plant Method. Mixing in a central plant shall continue until a homogeneous mixture meeting specified requirements is obtained, and no

varying appearance is evident. The mixing time may be adjusted by the Engineer as necessary.

308.03.9--Shaping, Compacting, and Finishing.

308.03.9.1--General. The mixed material shall be shaped as required immediately after mixing, or delivery to the roadbed in the case of central plant mixed material. Initial compaction shall begin immediately, and machining and compacting shall continue until the entire depth and width of the course is compacted to the required density within two hours of the time of beginning mixing. Compaction shall be by equipment and methods which do not result in lamination.

Areas inaccessible to rollers shall be compacted to the required density by other approved methods.

The addition of thin layers of cement-treated material in order to conform to cross sectional or grade requirements will not be permitted.

Compaction by vibration shall not be performed after the cement has taken its initial set. Vibratory compaction of a section shall be completed within one hour.

During compaction, a spike-tooth harrow or other suitable equipment shall be used as required to prevent lamination.

After the mixture, except the top mulch, is compacted, water shall be added as required to the mulch, and thoroughly mixed with a spike-tooth harrow or its equivalent to bring the mulch to the needed moisture content.

The surface shall then be reshaped to the required lines, grades, and cross section, and if necessary shall be lightly scarified to remove imprints left by the compacting or shaping equipment. The surface shall then be sprinkled as necessary and thoroughly rolled with a pneumatic roller, and if the mixture contains plus No. 4 aggregate, at least one complete coverage of the section shall be made with a steel-wheel tandem roller.

Surface compaction and finishing for the entire section shall be performed in a manner that will produce a smooth, closely knit surface, free from laminations, construction cracks, ridges, or loose material, and conforming to the crown, grade, and lines stipulated within four hours after the beginning of mixing.

Upon completion of compaction, testing will be performed in accordance with Subsections 700.03 and 700.04.

308.03.9.2--Density. Determination of acceptance of compaction of portland cement treated courses for required density will be performed on a lot to lot

basis. Each lot will be each 2,500 linear feet per layer placed. At the discretion of the Engineer, a residual portion of a lot completed during a day's operation may be considered a separate lot or may be included in the previous or subsequent lot, except that any day's operation of less than one full lot will be considered a lot.

The lot will be divided into five approximately equal sublots with one density test taken at random in each sublot. The average of the five (5) density tests shall equal or exceed 98.0 percent with no single density test below 94.0 percent. Sublots with a density below 94.0 percent shall be corrected at no additional cost to the State and retested for acceptance.

For cement treated materials other than for design soils and bases, the required density will be set out elsewhere in the contract.

308.03.9.3--Width, Thickness, and Surface Requirements. For the purpose of determining reasonable conformity with the designated width of a treated course, it shall be understood that the width of a treated course shall not vary from the designated edge lines by more than plus or minus one inch.

For the purpose of determining reasonable conformance with the designated thickness of a treated course, it shall be understood that the depth of a treated course shall not vary from the designated thickness by more than plus or minus one inch.

The finished surface of a treated course shall conform to the requirements shown on the plans, within the tolerances allowable under Section 321.

308.03.10--Protection and Curing. Each completed course shall be covered with a bituminous curing seal as soon as possible but no later than 24 hours after completion. The surface shall be sealed with one of the specified bituminous materials applied by a pressure distributor at the rate of 0.10 to 0.25 gallon per square yard or as directed by the Engineer. The bituminous material shall be heated or otherwise prepared to insure uniform distribution. Should the Contractor fail to seal the treated course within the time specified, the Engineer will suspend all other work and withhold payment of the current estimate(s) until all damages resulting there from is corrected and the treated course is sealed.

A subsequent course shall not be placed on the sealed course for at least seven (7) calendar days. During this 7-day period, the treated course shall not be subjected to any type of traffic and equipment.

The Contractor shall maintain the treated course and the curing seal in a satisfactory condition until covered by a subsequent course. Protection shall include immediate repairs of any surface irregularities or other defects that may occur or develop. It shall be the Contractor's responsibility to control traffic and

equipment loads to avoid damage and to guard against freezing of the treated material.

All damage resulting from the Contractor's failure to protect and cure the treated course as specified herein or from freezing that may occur prior to being covered with the next course shall be corrected at no additional cost to the State.

The Contractor shall submit, for approval of the Engineer, a method of correction that will restore the strength of the damaged material to that originally specified.

308.03.11--Maintenance. The Contractor shall maintain the cement treated course and the curing seal in a satisfactory condition until covered by a subsequent course. Maintenance shall include immediate repairs of surface irregularities or other defects that may occur. It shall be the Contractor's responsibility to control traffic and equipment loads to avoid damage and to guard against freezing of the course. All maintenance shall be performed at the expense of the Contractor and repeated as necessary to keep the cement treated material and the curing seal intact.

308.04--Method of Measurement. Portland cement incorporated in the accepted work, subject to the limitations set out in Subsection 308.03.7.1, will be measured by the ton, as designated, in accordance with the provisions of Section 109.

Accepted soil-cement-water mixing will be measured by the square yard or ton.

Contractor furnished materials will be measured and paid for in accordance with the provisions for the governing pay items shown in the contract.

Water and bituminous materials for the curing seal will not be measured for separate payment.

Unauthorized wastage or usage of any materials, unused materials remaining in stockpiles, and additional materials required for reconstruction of unacceptable work will be deducted from measured quantities. Determination of quantities to be deducted will be made by the method the Engineer considers to be most practicable and equitable, and the Contractor's decision as to the method used shall be final.

308.05--Basis of Payment. Portland cement will be paid for at the contract unit price per ton. Soil-cement-water mixing will be paid for at the contract unit price per square yard or ton, as specified. The prices thus paid shall be full compensation for completing the work.

Payment will be made under:

308-A: Portland Cement

- per ton

308-B: Soil-Cement-Water Mixing, Type* Mixers,
Component

- per square yard
or ton**

* Optional, Single Pass, Multiple Pass, Traveling Plant, or Central Plant.

** Central Plant Mixers Only.

SECTION 309 – CRUSHED STONE DRAINAGE LAYER

309.01--Description. This work shall consist of the construction of a drainage layer composed of a crushed stone 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.

309.02--Materials. The aggregate shall meet the requirements of Subsection 704.06.

309.03--Construction Requirements.

309.03.1--Weather Limitations. The drainage layer shall not be placed on a wet or frozen surface, or when weather conditions prevent proper handling, compacting or finishing of the mixture.

309.03.2--Stockpiling. Stockpiles shall be constructed and aggregates shall be reclaimed from the stockpile so as to minimize segregation. Aggregates that have been mixed with earth or foreign material, or become coated with undesirable material shall not be used.

309.03.3--Spreading. The drainage layer aggregate shall be spread, as uniformly as possible with a minimum of manipulation to prevent segregation, using an asphalt laydown machine or spreader box with automatic grade controls. On areas where irregularities or unavoidable obstacles preclude spreading by mechanical equipment, the mixture shall be deposited, spread and finished by hand tools.

309.03.4--Compaction. Pneumatic-tired rollers, or vibratory rollers shall be used to provide densification of the material. One or more control strips, minimum of 500 feet in length and 12 feet wide, shall be constructed at the beginning of the work for the purpose of determining project compaction requirements. An additional control strip shall be constructed whenever a change is made in the type or source of material, whenever a change occurs in the composition of the material from the same source, or as directed by the Engineer.

Each control strip shall consist of the same material and thickness as that specified for the completed layer,. Each accepted control strip shall remain in place and become a portion of the completed drainage layer.

The control strip shall be compacted by a minimum of four (4) passes with the compaction equipment. A pass is defined as one passage of any one tire or compacting wheel unit over the entire surface of the layer. Compaction shall continue until no appreciable increase in density is obtained by additional passes, as monitored using a nuclear density gauge, without crushing of aggregate.

No specific percentage of density will be required. The rolling pattern, number of passes, as determined in the control strip shall be used to compact the drainage layer.

309.03.5--Shaping and Finishing. The surface of the drainage layer shall be shaped to the required cross-section. Prior to placement of any HMA lift, all surface deficiencies shall be corrected.

309.03.6--Tolerances. The surface tolerance shall be $\pm 3/8$ inch when tested after final rolling using a 10-foot straightedge at selected locations. Low areas exceeding this requirement shall be corrected by adding material, grading and compacting. A material transfer unit may be required to meet the specified surface tolerances.

The maximum allowable thickness deficiency shall be $3/8$ inch. When the deficiency exceeds this requirement, the thin area shall be corrected by adding material, grading and compacting to proper thickness.

309.03.7--Construction Traffic and Equipment Restriction. Construction traffic and equipment operating on the completed drainage layer shall be restricted to only that directly involved in placement of the first HMA course. The drainage layer shall not be used as a haul road for delivery of materials. Trucks delivering paving materials shall enter immediately in front of the paver and after emptying, shall depart immediately therefrom. Twisting and turning traffic shall not be allowed. The Contractor shall protect the drainage layer from becoming clogged with dirt or foreign materials resulting from the operation of construction traffic and equipment. Damage to drainage layer by construction traffic and equipment shall be corrected through repair or replacement of the damaged area at no additional cost to the State.

309.04--Method of Measurement. Crushed stone drainage layer will be measured by the square yard, cubic yard (LVM), or ton, as indicated in the bid schedule of the contract.

When the method of measurement is by the square yard, the width for measurement will be the plan width, including widening where called for, or as

otherwise authorized in writing by the Engineer. The length will be measured horizontally in accordance with Section 109.

When the method of measurement is by the ton, measurement will be made on the dry unit weight basis. The moisture determination for computing the dry unit weight will be made in accordance with the methods as provided in Subsections 700.03 and 700.04 at least once a day and as many additional times as the Engineer deems necessary

309.05--Basis of Payment. Crushed stone drainage layer, complete in place, accepted and measured as prescribed above, will be paid for at the contract unit price per unit specified in the bid schedule of the contract, and shall be full compensation for furnishing all labor, equipment, materials, tools, and supplies, and for all other costs including producing, screening, loading, hauling, stockpiling the crushed stone drainage layer aggregate; spreading and compacting the drainage layer, and all other work necessary for the construction of the crushed stone drainage layer.

Payment will be made under:

309-A: Crushed Stone Drainage Layer	- per square yard, cubic yard, or ton

SECTION 310 - MECHANICALLY STABILIZED COURSES

310.01--Description. This work consists of constructing one or more courses by the incorporation of stabilizer aggregate in accordance with these specifications and in reasonably close conformity with the lines, grades, and typical cross sections shown on the plans or established by the Engineer.

310.02--Materials.

310.02.1--Materials to be Stabilized. The material to be stabilized shall consist of base material placed under this contract or under a previous contract.

General conditions governing the use of materials shall be as set out in Section 106.

310.02.2--Stabilizer Aggregates. Stabilizer aggregates of the kind and size specified shall meet the requirements of Subsection 703.20.

310.02.3--Composite Mixture. The composite mixture of mechanically stabilized courses shall be in accordance with the requirements and provisions of Subsection 703.08. In order to obtain the desirable composite mixture, the Engineer may vary the quantity of stabilizer aggregate shown on the plans by as

much as 25 percent.

Acceptance of the composite mixture for conformance to the specification requirements for gradation, liquid limit and plasticity index shall be based on samples obtained from the roadway. A minimum of one random sample shall be obtained for each 1000 linear feet of 24 foot lane. In case a sample fails to meet the requirements of the specifications, additional samples shall be obtained to locate the limits of the non-conforming material. Such non-conforming material shall be corrected by the Contractor, at no additional costs to the State, prior to final acceptance.

310.03--Construction Requirements.

310.03.1--General. The first section of each course to be constructed will serve as a test section. The length of the test section will be determined by the capability of the equipment selected to perform the work, but will be at least 1000 linear feet but not more than 1500 linear feet for the designated width. The Engineer and the Contractor will evaluate results of the test section in relation to contract requirements. In case the Engineer determines the work is not satisfactory, the Contractor shall revise procedures and augment or replace equipment as necessary to assure work completed in accordance with the contract, and shall correct all deficient work at no additional cost to the State.

For the purpose of determining reasonable conformity with the designated width of a course, the width of a course shall not vary from the designated edge lines by more than plus or minus three inches.

Courses designated to be more than eight inches thick shall be constructed in two or more layers of approximately equal thickness. The maximum compacted thickness of any one layer shall not exceed eight inches.

When the plans indicate multiple courses, each course shall be mixed or spread, shaped, and compacted separately. Multiple courses shall be constructed so that each course is in direct contact with the preceding course, and a cushion of unstabilized material between layers will not be permitted.

When material for shoulders is of a different class or type from that specified for the course being constructed, the partial formation of shoulders shall precede the placement of aggregate or plant mixed material. Temporary drainage as necessary through partially constructed shoulders shall be provided and maintained until construction of the contiguous course.

No material shall be placed on or mixed with frozen material.

310.03.2--Equipment. Watering equipment shall have pressurized spray bars with suitable nozzle openings.

Mixing shall be performed with multiple pass mixers, single pass mixers, traveling mixing plants, or central mixing plants. Unless otherwise specified, the type mixer used will be at the option of the Contractor.

Mixing equipment shall meet the applicable requirements of Subsection 308.03.2.

Rollers shall be of sufficient number, type, size, and weight to accomplish the required compaction.

When measurement for payment is to be made by the ton, the Contractor shall furnish approved platform scales capable of weighing the entire loaded vehicle. Scales and their use shall be in accordance with the requirements set out in Subsection 401.03.2.1.11, except they shall be installed at an approved location on or near the project.

310.03.3--Preparation of Grade. Prior to placing material, the foundation shall be prepared in accordance with the requirements of Section 321 for a sufficient distance in advance to insure proper prosecution of the work.

310.03.4--Preparation of Materials. The material to be stabilized shall be reasonably free from clay balls, roots, grass, organic matter, and other deleterious substances.

310.03.5--Application of Stabilizer Aggregate (Road Mix Method). When the roadbed has been prepared and approved, aggregate in the quantity specified shall be uniformly spread.

The Contractor shall provide sufficient equipment and shall organize the work so that the time interval between dumping and spreading of aggregate and subsequent incorporation shall be the minimum necessary to carry on an efficient and continuous operation. Dumping of long lines of aggregate on the roadbed and prolonged periods of hauling adjacent thereto will not be permitted. Unless prevented by unavoidable conditions, aggregate shall be incorporated, mixed, shaped, compacted, and finished not later than the second day following delivery to the roadbed.

310.03.6--Mixing.

310.03.6.1--General. During the mixing operations, clay balls and other undesirable materials present in sufficient quantity to impair the quality of the course shall be removed.

310.03.6.2--Road Mix Method. After the stabilizer aggregate has been uniformly spread, the material shall be scarified, if necessary, and the mixing operation begun immediately.

All preliminary scarifying and mixing shall be carefully controlled to provide an undisturbed foundation course with the designated grade and cross section.

The Contractor shall be responsible for damage to or contamination with the underlying material or shoulder material, and shall make corrections and repairs as necessary at no additional cost to the State.

All material to be stabilized shall be thoroughly mixed and pulverized by incorporating the added materials so that the course will be homogeneous throughout. During the mixing operation, water shall be applied as necessary to provide the needed moisture content for obtaining the required density.

Particular care shall be exercised to insure satisfactory moisture distribution along the edges of the course, and to avoid the application of excess water on any portion of a section.

310.03.6.3--Central Plant Method. Water shall be added during the mixing operation in the quantity necessary to provide the needed moisture content. Mixing shall continue until a homogeneous mixture is obtained. After the mixing is complete, the mixture shall be transported while at the proper moisture content for compaction, and shall be placed on the prepared grade by means of an aggregate spreader.

The Contractor shall deliver to the roadbed a sufficient quantity of mixed material to produce the designated course. All material placed in excess of the tolerances allowable in Section 321 shall be removed and hauled from the project without compensation, or removed and placed at other approved locations requiring use of the same material.

310.03.7--Spreading, Compacting, and Finishing. The mixed material shall be spread immediately after mixing, or after delivery in the case of central plant mixed material.

Spreading shall be carried out in a manner that will minimize segregation and will result in a completed course within the tolerances allowable.

Compaction shall start longitudinally at the outer edges of the course and proceed toward the center. The material shall be sprinkled or aerated as necessary during compaction to maintain the needed moisture content.

Shaping and compaction shall be carried out in such a manner as to prevent lamination and shall continue until the entire depth and width of the course has obtained the required density. Throughout the entire compaction operation, the shape of the course shall be maintained by blading and rolling. Surface compaction and finishing shall be performed so as to produce a smooth, closely knit surface, free from lamination, cracks, ridges, or loose material, and

conforming to the required section and the established lines and grades within the tolerances allowable.

Prior to subsequent construction, all irregularities, depressions, soft spots, and other deficiencies shall be corrected to meet the requirements of these specifications at no additional cost to the State.

After compaction and finishing, if the mixture contains plus No. 4 aggregate and the course is to serve as a base for bituminous pavement, at least one complete coverage shall be made with a steel wheel roller. The Engineer may waive this requirement for shell stabilized bases.

In addition to the requirements for density and correction of irregularities, depressions, or soft spots, the Contractor shall be fully responsible for constructing and maintaining a course which will remain firm and stable under all construction equipment and other traffic to which the course is subjected prior to the acceptance of the work.

Density tests will be performed in accordance with the methods as provided in Subsections 700.03 and 700.04.

Determination of acceptance of compaction of mechanically stabilized courses for required density will be performed on a lot to lot basis. Each lot will be each 2,500 linear feet per layer placed. At the discretion of the Engineer, a residual portion of a lot completed during a day's operation may be considered a separate lot or may be included in the previous or the subsequent lot, except that any day's operation of less than one full lot will be considered a lot.

The lot will be divided into five approximately equal sublots with one density test taken at random in each subplot. The individual tests and the average of the five tests shall equal or exceed the values as shown in the table below. For any course which is to be subsequently chemically treated, the average of the five density tests shall equal or exceed 93.0 percent with no single density test below 89.0 percent.

Composite Mixture		
Type	Lot Average	Individual Test
A	102.0	98.0
B	100.0	96.0
C	99.0	95.0
D	97.0	93.0

The finished surface of all courses shall conform to the required section and the established lines and grades, within the tolerances allowable under Section 321. All finished courses shall be continually maintained until covered by a subsequent course or the work released from maintenance.

310.04--Method of Measurement. Mixing, shaping, and compaction will be measured by the square yard, station, or mile, as designated, for each course included in the contract.

Stabilizer aggregate will be measured by the cubic yard (LVM) or by the ton, as designated in the bid schedule of the contract. Other materials (except water) specified and incorporated into accepted work will be measured and paid for under the provisions of the governing pay items shown in the contract. When the method of measurement is by the ton, measurement will be made on the dry unit weight basis at the point of weighing. The moisture determination for computing the dry unit weight will be made in accordance with the methods set out in Subsection 700.03 at least one time each day, and as many additional times as the Engineer deems necessary. Water will not be measured for payment.

Unauthorized wastage or usage of materials, unused materials remaining in stockpiles, and additional materials required for correction of unacceptable work will be deducted from measured quantities. Determination of quantities to be deducted will be made by the method the Engineer considers to be most practicable and equitable, and the Engineer’s decision as to the method used for such computations shall be final.

310.05--Basis of Payment. Mixing, shaping, and compaction will be paid for at the contract unit price per specified unit. Stabilizer aggregates will be paid for at the contract unit price per specified unit. The prices thus paid shall be full compensation for completing the work.

Payment will be made under:

- 310-A: Mixing, Shaping, and Compaction,
Type____, Group____ - per square yard, station,
or mile
- 310-B: Size____ Stabilizer Aggregate, Coarse - per cubic yard or ton
- 310-C: Stabilizer Aggregate, Shell - per cubic yard or ton
- 310-D: Stabilizer Aggregate, Medium - per cubic yard or ton
- 310-E: Stabilizer Aggregate, Fine - per cubic yard or ton

SECTION 311 - LIME-FLY ASH TREATED COURSES

311.01--Description. This work consists of constructing one or more courses of a mixture of soil, soil aggregate or aggregate, fly ash, lime, and water in accordance with these specifications and in reasonably close conformity with the

lines, grades, thickness and typical cross sections shown on the plans or established by the Engineer.

Unless otherwise provided, the Contractor may use either the travel plant or central plant method.

311.02--Materials. Soil, soil aggregate or aggregate, when Contractor furnished, shall conform to the requirements set forth on the plans or in the contract. Other materials shall conform to the requirements of Division 700 as specified in the following subsections:

Cut-back Asphalt	702.06
Emulsified Asphalt	702.07
Aggregate	703.20
Water	714.01
Lime	714.03
Fly Ash	714.05

311.02.1--Soil-Lime-Fly Ash Design. Quantities and percentages of lime and fly ash shown on the plans are preliminary. The actual application rate will be established from tests made prior to beginning treatment. The design of soil-lime-fly ash courses shall be performed by the Central Laboratory. At least 45 days prior to the proposed use of a lime-fly ash course, the Contractor shall make available materials conforming to the specifications and proposed for use in the mixture for sampling and testing by the Department as the Engineer may consider necessary for the establishment of a mix design.

The approved proportions of material will govern during the progress of the work, and changes in source or character of any material shall not be made without approval. Approval will be based on verification of a mix design.

311.02.2--Curing Seals. Curing seal shall be Emulsified Asphalt, Grade EA-1, SS-1, CMS-2h, or MS-2h meeting the applicable requirements of Section 702.

311.03--Construction Requirements.

311.03.1--General. Fly ash shall be spread at the specified rate and lightly disked or mixed into the soil or soil aggregate prior to spreading the lime.

Prior to the application of fly ash, a light windrow shall be bladed along the edges of the area to be treated, or the surface on which the fly ash is to be applied shall be scarified to retain the spread fly ash. The depth of scarification shall be carefully controlled so that the surface of the roadbed below the scarified material will remain undisturbed and conform to the established cross section.

311.03.2--Equipment. Equipment necessary for the proper prosecution of the

work shall meet the applicable requirements of Subsection 308.03.2.

311.03.3--Preparation of Grade. Before treatment, the roadbed shall be prepared in accordance with the requirements of Section 321.

311.03.4--Application.

311.03.4.1--Fly Ash. Fly ash shall be applied as set out in Subsection 308.03.7, except that weather limitations shall be in accordance with Subsection 311.03.5.

311.03.4.2--Lime. The rate of application of lime shall be as specified.

Application of lime shall be accomplished by either an approved "dry application" or "slurry application" method.

The following guide lines will govern the acceptability of the method to be used:

Dry Application. Hydrated lime applied by this method shall be spread uniformly and shall be sprinkled with sufficient water to prevent loss of lime by wind. Spreading of hydrated lime when wind and weather conditions are unfavorable will not be permitted nor will spreading of lime by motor patrol be acceptable. The use of quick lime in the "dry application" method will not be permitted.

Slurry Application. Lime applied by this method shall be mixed with water in approved agitation equipment and applied to the roadbed as a thin water suspension or slurry. The distributing equipment shall be equipped to provide continuous agitation of the slurry until applied on the roadbed. The proportion of lime shall be such that the "Dry Solids Content" shall be at least 30 percent by weight.

The distribution of lime at the rate specified shall be attained by one or more passes over a measured section until the specified percentage of lime has been spread. After each successive pass the material shall be incorporated into the soil with the mixing equipment.

311.03.5--Weather Limitations. Lime-fly ash treatment shall not be performed when either the soil or soil aggregates or the surface on which a lime-fly ash treated material is to be laid is wet or frozen or when it is raining or snowing. Processing operations for the lime-fly ash course shall not begin until the surface temperature is at least 40°F and rising. Construction of the soil/soil aggregate-lime-fly ash stabilized course will not be permitted between November 30 and March 1.

311.03.6--Fly Ash-Lime and Water Mixing Phase. The lime and water shall be incorporated uniformly into the soil course of fly ash and aggregate. The

mixing and water application shall be continued until a homogeneous mixture of which 100 percent of the material by dry weight, exclusive of gravel and stone, will pass a two-inch sieve and 60 percent will pass a No. 4 sieve. At the completion of moist mixing and during the compaction operations, the percentage of moisture shall be that necessary to obtain the required density. No mellowing period will be required or permitted, and compaction shall begin immediately. The mixing, water application, and final compaction shall be completed during the same work day.

311.03.7--Shaping, Compacting, and Finishing. The shaping, compacting, and finishing shall be in accordance with the provisions and requirements of Subsection 308.03.9, except that, for the purpose of determining reasonable conformance with the designated thickness of the treated course, it shall be understood that the depth of the treated course shall not vary from designated thickness by more than minus one-half ($1/2$) inch or plus one (1) inch.

311.03.8--Protection and Curing. Each completed course shall be covered with a bituminous curing seal as soon as possible but no later than 24 hours after completion. The surface shall be sealed with one of the specified bituminous materials applied by a pressure distributor at the rate of 0.10 to 0.25 gallon per square yard or as directed by the Engineer. The bituminous material shall be heated or otherwise prepared to insure uniform distribution. Should the Contractor fail to seal the lime-fly ash course within the time specified, the Engineer will suspend all other work and withhold payment of the current estimate(s) until all damages resulting therefrom is corrected and the lime-fly ash course is sealed.

A subsequent course shall not be placed on the sealed lime-fly ash course for at least seven (7) calendar days. During this 7-day period, the lime-fly ash course shall not be subjected to any type of traffic and equipment.

The Contractor shall maintain the lime-fly ash course and the curing seal in a satisfactory condition until covered by a subsequent course. Protection shall include immediate repairs of any surface irregularities or other defects that may occur or develop. It shall be the Contractor's responsibility to control traffic and equipment loads to avoid damage and to guard against freezing of the lime-fly ash treated material.

All damage resulting from the Contractor's failure to protect and cure the lime-fly ash course as specified herein or from freezing that may occur prior to being covered with the next course shall be corrected at no additional cost to the State.

The Contractor shall submit, for approval of the Engineer, a method of correction that will restore the strength of the damaged material to that originally specified.

311.04--Method of Measurement. Lime and fly ash will be measured by the

ton in accordance with Section 109. If bagged lime is used, the net weight as packaged by the manufacturer will be used for measurement.

The basis of pay for jobsite slaked lime slurry shall be the "calculated method" as provided for jobsite slaked lime slurry in Subsection 307.04.

Aggregate will be measured by the ton or cubic yard (LVM). When measurement is by weight, the weight of moisture, surface and hygroscopic, will be deducted.

Processing will be measured by the square yard and shall include preparation of the roadbed, scarifying, pulverizing, drying of the material, mixing of the various materials, compaction of the mixture, finishing, protection and curing, and maintenance of the completed course.

Water and curing seal will not be measured for separate payment.

311.05--Basis of Payment. The accepted quantities of lime and fly ash treated material will be paid for at the contract price per ton for lime and fly ash, per ton or cubic yard (LVM) for aggregate, and per square yard for processing lime and fly ash treated material complete in place. The prices thus paid shall be full compensation for completing the work.

Payment will be made under:

- 311-A: ____” Processing Lime and Fly Ash Treated Course - per square yard
- 311-B: Lime - per ton
- 311-C: Fly Ash, Class____ - per ton
- 311-D: Aggregate - per cubic yard or ton

SECTION 320 - SHOULDERS

320.01--Description. This work consists of constructing the shoulder portion of courses specified to be constructed; the shaping, compacting, finishing, and surfacing, if required, of the shoulder portion of the work in reasonably close conformity with the required lines, grades, and cross sections; and the construction and establishment of erosion control items specified for the shoulder portion of the work. All work shall conform to the sequence and timing indicated herein and to the other applicable requirements of the contract.

This work shall also include preservation from injury or damage to and repair and reconstruction of, if necessary, underlying courses and other elements of the

pavement structure. Except as otherwise specified, construction of shoulders shall also include reshaping, finishing, and mowing of cut ditches, foreslopes, and upper embankment slopes adjacent to shoulders. Areas to receive this work shall include the areas between the finished shoulder line and the same elevation at the back of the ditch in cut sections and the areas on fill slopes between the finished shoulder line and a line 12 feet horizontally outside the finished shoulder line. Similar areas in the median portion of divided highways shall also be reshaped and finished.

320.02--Materials. Materials used in constructing shoulders shall meet the applicable requirements of Division 700.

320.03--Construction Requirements.

320.03.1--Preparation of Grade. Before beginning each course of shoulder construction, the foundation shall be prepared in accordance with Section 321.

320.03.2--Construction Details. Except as otherwise specified, the construction of each course of the shoulders shall be in accordance with controlling requirements for bases constructed of like material.

Shoulder construction shall begin at the earliest practicable time and proceed in the proper sequence with contiguous base or pavement construction. Each designated course for shoulders shall be constructed to the established lines, grades, and cross sections within tolerances allowable under Section 321 and shall be firm and stable; reference is made to Subsection 321.03.

Determination of acceptance of compaction of shoulders for required density will be performed on a lot to lot basis. Each lot will consist of each day's operation per layer placed, with a maximum lot length of 10,000 linear feet.

The lot will be divided into five approximately equal sublots with one density test taken at random in each sublot. The lot average and each single density test shall conform to the required density.

The required density for the shoulder portion of any layer or course shall be the same as for the adjacent (internal) portion of the layer or course when constructed of the same material.

The required density for the shoulder portion of any layer or course where the adjacent (internal) portion is of unlike material shall be as follows:

Granular Material	Lot	Individual
<u>Class</u>	<u>Average</u>	<u>Test</u>
10	94.0	90.0
7,8 or 9	95.0	91.0
5 or 6	96.0	92.0
3 or 4	97.0	93.0
1 or 2	98.0	94.0

except,

- (a) When the finished shoulder is required to be paved, the required density for such shoulder course shall be that required for the same material for bases, and
- (b) Where an existing pavement is to be overlaid, or widened and overlaid, without shoulder widening, and the existing shoulder is to be raised to match the new pavement, satisfactory density of each layer of new shoulder material shall be that which can be obtained from six coverages of a pneumatic roller with an operating weight of approximately six tons while the shoulder material is at the proper moisture content.

In cases of base or pavement in which portland cement is used as a material of construction, shoulder construction shall follow immediately upon expiration of the curing period, unless it has been otherwise provided that the shoulder course be constructed in advance of the contiguous course.

The rate of progress for each phase of shoulder construction shall be consistent with the rate of progress of the controlling construction. When the Engineer deems that other operations are being carried on to the unnecessary neglect of shoulder construction, the Engineer may suspend the operations in progress and order that shoulder construction be brought up to and then continued, without prejudice to other work, in the proper sequence.

320.04--Blank.

320.05--Basis of Payment. Unless otherwise specified in the contract, no separate payment will be made for shoulder construction. Payment will be made for the materials and their processing when set up in the contract as pay items. All additional work involved in shoulder construction is considered an obligation of the Contractor subsidiary to the placement of the materials required and work performed for which provisions for payment are contained in the contract.

SECTION 321 - IN-GRADE PREPARATION

321.01--Description. The term "in-grade" is defined as existing material in place

regardless of whether the material was placed under this contract or a previous contract. The term "in-grade preparation" is defined as the work required to prepare, blade, shape, scarify, disk, mix, compact, etc. the existing material to specification requirements prior to placement of a subsequent course of material.

Figure 1, Section 101, graphically defines the limits of the roadway, the design soil and the components of the pavement structure.

In-grade preparation shall be in reasonable close conformity with the lines, grades, and typical section(s) shown on the plans. All work will be performed in the sequence and timing specified.

Except as specifically provided herein, no direct compensation will be allowed for in-grade preparation.

321.01.1--Applicability. In-grade preparation will be required on all projects which require replacement of any component of a pavement structure or chemical treatment of the design soil.

In-grade preparation will not be required on pavements or chemically treated courses which are to remain in place undisturbed.

Unless otherwise specified, the in-grade preparation course shall be the top six inches of the design soil.

321.02--Blank.

321.03--Construction Requirements.

321.03.1--General. Prior to beginning in-grade preparation, the roadway will be cleaned of all vegetation or debris, bladed, shaped and filled as necessary to obtain the required line, grades and typical section as shown on the plans or as specified. The Contractor will perform unclassified excavation where required for grade changes, removal of temporary ramps at bridge ends, shape foreslopes and cut ditches to the required line, grade and typical section, and other work required to alter work performed on previous contracts. All material obtained in preparation prior to in-grade preparation work will be disposed of or utilized by the Contractor.

321.03.2--First In-Grade Course.

321.03.2.1--Design Soil. When the first in-grade preparation course is the top portion of the design soil, which was constructed under a previous contract, the top six inches, unless a greater depth is specified, shall be broken up, either by scarifying or blading to the specified depth and then thoroughly mixed by a disk-harrow. If the embankment design soil was constructed under this contract in

accordance with the requirements of Section 203, then only the cut section will require mixing as stated herein. The disk shall be of sufficient weight and size to cut a minimum depth of eight inches, or ten inches when eight inches design soil mixing is required, in loose material. After mixing with a disk-harrow, the roadway will be shaped and compacted to the proper section and density.

321.03.2.2--Component of Pavement Structure. When the first in-grade preparation course is a component of the pavement structure, other than design soil, the course shall be prepared by blading, shaping to the specified section, and compacting to the specified density for the particular layer being prepared.

321.03.3--Unsuitable Materials. All materials which cannot be stabilized and compacted to the required density, shall be removed and disposed of as directed. The material removed will be replaced by acceptable materials. Unless the unsuitable material was placed under this contract, the removal, disposal, and replacement of the material will be measured and paid for under the appropriate items of the contract. Materials, which meet contract requirements, except for moisture content will not be classified as unsuitable materials.

321.03.4--Stability. When density and stability cannot be obtained due to the instability of the underlying material, the Contractor will take the necessary action to stabilize and compact the underlying material. Unless the unstable material was placed under this contract, the work required to stabilize and compact the material will be paid for under the appropriate items of the contract. When the Contractor has initiated appropriate action to stabilize and compact the underlying material and density cannot be obtained, then the material will be classified as unsuitable and proceed in accordance with Section 321.03.3.

321.03.5--Haul, Protection and Repair. All materials hauled through or over any part of the project shall be hauled in the sequence and manner to cause the least damage to the previously placed course. The Contractor's operations shall provide the maximum protection to each course in place from deformation or contamination from underlying material.

The first course of material to be placed on a chemically treated design soil shall be placed by hauling to the point nearest the source of the material, thus hauling over the material being placed. Subsequent hauling shall be over the maximum practical thickness of material in order to provide the greatest protection to the underlying material.

The Contractor shall satisfactorily maintain the material over which he is hauling, and the materials being hauled shall be spread as hauling progresses to prevent hauling equipment from repetitive passes alongside lines of dumped and unspread material.

The Contractor shall repair, at no additional cost to the State, all damage to

prepared in-grade material whether the material was placed under this contract or under previous contract.

321.03.6--Density. The required density for in-grade preparation of courses which do not require a chemical treatment or modification shall be the required density for the particular course. The required density for courses which require chemical treatment or modification shall be 93.0 percent prior to the addition of the chemical, stabilizer or modification.

321.03.7--Tolerances.

321.03.7.1--General. It shall be understood that although certain tolerances in grade, cross section, and density are allowable under the specifications, it shall be the Contractor's responsibility to prepare the surface of all in-grade courses to the degree of true grade and cross section and to the density and stability necessary to insure the ability to construct subsequent courses to the specified requirements for surface, thickness, and compaction. It is essential in pavement structure construction that the degree of accuracy must be increased for each succeeding course in order that the final surface requirements can be met and the thickness of each course will be within design tolerances. It shall be the Contractor's responsibility to construct each course to the degree of accuracy, maximum allowable tolerances notwithstanding, necessary to insure meeting final requirements.

321.03.7.2--Vertical Tolerances. No vertical tolerances will be allowed which will pond water. Otherwise, allowable tolerances will be as follows:

321.03.7.2.1-For Design Soil.

Tolerances from Design Grade:

- a. Where the top portion of the design soil is to be lime treated or lime-fly ash treated and the next course is stone or is to be chemically treated -
 - Before Treatment -1" (1)
 - Treatment In Place ±1" (2)

- b. Where the top portion of the design soil is to be cement treated and the next course is stone or is to be chemically treated -
 - Before Treatment -1"
 - Treatment In Place -1"

- c. Where the design soil is not to be treated and the next course is stone or is to be treated or untreated -
 - Preparation In Place -1"

- d. Where the design soil is not to be treated and a superimposed course is not required under this contract -

- In Place ±1"

Notes: (1) From the design grade established before spreading lime to allow for bulking.
(2) From the design grade established for bulked material.

321.03.7.2.2--For Bases.

The surface tolerances from design grade before placing base material shall be the tolerances from design grade in place as set out herein for design soils.

Grade stakes or other reference points shall be set at 25-foot intervals; when tested longitudinally, the maximum deviation when measured at the midpoint (12 1/2 feet) shall be ±1/2 inches.

- a. Where a base course is not to be treated and the next course is to be bituminous pavement -

- In Place ±1/2"

- b. Where a base course is stone or is to be cement treated and the next course is a drainage layer -

- In Place ±1/2"

- c. Where a base course is to be lime-fly ash treated and the next course is a drainage layer -

- In Place ±1/2" (3)

- d. Where a base course is stone or is to be cement treated and the next course is to be bituminous pavement -

- In Place ±1/2"

- e. Where a base course is to be lime-fly ash treated and the next course is to be bituminous pavement -

- In Place ±1/2" (3)

Note: (3) From the design grade established for bulked material.

Where stone is specified, it shall meet the requirements of Section 304.

321.03.7.2.3-For Drainage Layers.

Tolerances from Design Grade:

Where a drainage layer is required - - In Place +1/8" to -3/8"

321.03.7.2.4--For Any Course.

Tolerances from Design Grade:

- a. Where a course is to be stone or is to be treated or untreated and the next course is a drainage layer or bituminous pavement -

- In Place $\pm 1/2"$

- b. Where a course is stone or is to be treated, followed by a drainage layer and portland cement concrete pavement -
 - Under the Form Line or Track Line $\pm 1/8"$ (4)
 - Elsewhere -1" (5)

Notes: (4) The Contractor may construct the course at the form line to a tentative grade having a tolerance of not more than minus 1/2 inch, in which case the Contractor shall, at no additional cost to the State, bring the surface of the base at the form line to the specified grade and density with materials and methods approved by the Engineer and consistent with the requirements for foundation formation for forms or tracks required under the contract.

- (5) Provided the Contractor places at no additional cost to the State, at the time of placing portland cement concrete base course or pavement, the additional concrete necessary to compensate for the deficiency from a true design base grade.

321.03.7.2.5--For Mechanical Stabilization and In-Grade Modification.

Where material is to be mechanically stabilized or modified with stabilizer aggregate or other materials on the roadbed, the tolerance from design grade, both before spreading the aggregate and after mechanical stabilization, shall be those as respectively set out hereinbefore with an appropriate allowance having been made in the grade prior to spreading the aggregate to compensate for anticipated bulking.

321.03.7.2.6--Thickness. Unless otherwise specified and except for chemical treatment, mechanical stabilization, in-grade modification, and in-grade preparation of the top portion of the design soil, no thickness determination as such will be required for bases. The preceding tolerances from design grade shall determine the tolerance limits for thickness.

The thickness tolerance for in-grade preparation of the top portion of design soil shall be plus or minus one inch. For chemical treatment, mechanical stabilization, or in-grade modification, thickness tolerances shall be those set out in the sections applicable to the required courses.

321.03.7.3--Horizontal Tolerances. Allowable horizontal tolerances for in-grade preparation shall be those set out in the respective sections for the required courses. Where no horizontal tolerance is specified, the tolerance for a course shall be that which will not result in an unsightly appearance or detract from the esthetic value of the finished crown line and slope.

Each course of base and shoulder materials, and combined courses of shoulder materials and the top portion of the design soil shall be shaped in such a manner that after compaction the finished course and combined courses shall closely conform to the widths, lines grades, and cross sections shown on the plans or established.

321.04--Method of Measurement. Unless shown as a separate pay item in the proposal, in-grade preparation will not be measured for direct payment, but shall be considered a necessary part of the construction involved, and the cost thereof shall be included in the appropriate contract unit prices.

When shown as a separate pay item, in-grade preparation of the depth specified will be measured by the mile for each separate roadway of the main facility without respect to width or number of lanes or courses involved. No separate measurement for payment will be made for frontage roads, interchanges, intersections, entrances, or other features of the work, nor for intersecting roads unless such roads are set out under the contract as separate projects. It shall be understood that the cost of in-grade preparation for such subsidiary facilities is included in the contract unit price per mile for the main facility.

In the case of in-grade preparation of material in place under previous contract, if it is necessary to excavate, pickup, load, and haul any of the in-grade material for use at other locations or for disposal as directed in order to prepare the section in accordance with the design grade, typical sections and conditions specified, such work shall be performed and will be measured and paid for under the applicable provisions and requirements as follows:

- a. When designated in the contract, under the provisions and requirements designated.
- b. When material loaded and hauled is used in lieu of material required under another item, measurement and payment will be made under the item of use.
- c. Measurement and payment for base or pavement material required in the work performed will be made in accordance with the requirements and provisions for use of such material.
- d. When an item of excavation is not included in the contract, excavation required by the Engineer to be picked up, loaded, and hauled to other

locations will be paid for as Extra Work or at unit prices established by supplemental agreement.

- e. Necessary haul of material not specified to be furnished by the Contractor, or not designated as absorbed haul (AH), shall be performed and will be paid for as provided under Section 205, or, in the event the contract does not provide a unit bid price for haul, as Extra Work.

321.05--Basis of Payment. Except as provided above, no payment will be made for in-grade preparation. It shall be fully understood that compensation: for all specified scarifying, disk-harrowing, mixing, or other processing; for furnishing and applying all water; for all aerating necessary to dry wet materials; for all shaping and compacting; for all other work of whatever nature necessary for preparation as set forth under this section; and for furnishing all labor, tools, equipment and incidentals necessary to complete the work shall be included in the unit prices for the materials used and the work performed under contract items.

When shown as a separate pay item in the contract, in-grade preparation will be paid for at the contract unit price per mile, which price shall be full compensation for satisfactorily completing the work.

Payment will be made under:

321-A: ____ " In-Grade Preparation - per mile

DIVISION 400 - BITUMINOUS PAVEMENTS**SECTION 401 - HOT MIX ASPHALT (HMA) - GENERAL**

401.01--Description. These specifications include general requirements that are applicable to all types of HMA along with the specific requirements for each particular mixture when deviations from the general requirements are necessary.

This work consists of the construction of one or more lifts of HMA in accordance with these specifications and the specific requirements for the mixture to be produced and in reasonably close conformity with the lines, grades, thicknesses and typical sections shown on the plans or established by the Engineer.

401.01.1--Definitions.

Maximum Sieve Size - Maximum sieve size is the smallest sieve size at which 100 percent of the aggregate passes.

Nominal Maximum Sieve Size - The nominal maximum sieve size is one sieve size larger than the first sieve to retain more than 10 percent of the aggregate.

Maximum Density Line - The maximum density line is a straight line plot on the FHWA 0.45 power gradation chart which extends from the zero origin point of the chart through the plotted point of the combined aggregate gradation curve on the nominal maximum sieve size.

Mechanically Fractured Face - An angular, rough, or broken surface of an aggregate particle created by crushing as determined by ASTM Designation: D 5821.

401.02--Materials.**401.02.1--Component Materials.**

401.02.1.1--General. Component materials will be conditionally accepted at the plant subject to later rejection if incorporated in a mixture or in work which fails to meet contract requirements.

401.02.1.2--Aggregates. The source of aggregates shall meet the applicable requirements of Section 703.

401.02.1.2.1--Coarse Aggregate Blend. Mechanically fractured faces by weight of the combined mineral aggregate coarser than the No. 4 sieve:

<u>Mixture</u>	<u>Percent Fractured Faces, minimum</u>
25 mm	70, one-face
19 mm*	80, one-face
12.5 mm	90, two-face
9.5 mm	90, two-face
4.75 mm	90, two-face

* When used on routes requiring polymer modified asphalt, the top intermediate lift (19 mm mixture), including travel lane and adjacent lane, shall have at least 90 percent two fractured faces minimum. When placed on an existing Portland Cement Concrete surface, all intermediate lifts (19 mm mixture) shall have at least 90 percent fractured two faces minimum.

The maximum percentage by weight of flat and elongated particles, for all mixes other than 4.75 mm, maximum to minimum dimension greater than 5, shall not exceed 10% for all mixtures. This shall be determined in accordance with ASTM Designation: D 4791, Section 8.4, on the combined mineral aggregate retained on the 3/8” sieve.

401.02.1.2.2--Fine Aggregate Blend. Of all the material passing the No. 8 sieve and retained on the No. 200 sieve, not more than 60 percent shall pass the No. 30 sieve.

Uncrushed natural sand shall pass the 3/8” sieve and may be used, excluding the content in RAP, in the percentages of the total mineral aggregate by weight set out in the following table:

Mixture	Maximum Percentage of Natural Sand by Total Weight of Mineral Aggregate		
	HT	MT	ST
25 mm	10	10	20
19 mm	10	10	20
12.5 mm	10	10	20
9.5 mm	10	10	10
4.75 mm	25	30	35

401.02.1.2.3--Combined Aggregate Blend.

Design Master Range

Mixture:	25 mm	19 mm	12.5 mm	9.5 mm	4.75 mm
Nominal Maximum Sieve Size:	1 inch	3/4 inch	1/2 inch	3/8 inch	1/4 inch
Sieve Size	Percent Passing				
1-1/2 inch	100				
1 inch	90-100	100			
3/4 inch	89 max.	90-100	100		
1/2 inch	-	89 max.	90-100	100	100
3/8 inch	-	-	89 max.	90-100	95-100
No. 4	-	-	-	89 max.	90-100
No. 8	16-50	18-55	20-60	22-70	-
No. 16	-	-	-	-	30-60
No. 200	4.0-9.0	4.0-9.0	4.0-9.0	4.0-9.0	6.0-12.0

For MT and HT mixtures, the combined aggregate gradation of the job mix formula, when plotted on FHWA 0.45 power chart paper, shall fall entirely below the Maximum Density Line on all sieve sizes smaller than the No. 4 sieve. However, MT and HT mixtures having a minimum fine aggregate angularity index of 44.0, per ASTM Designation: C1252, Method A, may be designed above the maximum density line.

The 9.5 mm mixtures shall have a minimum fine aggregate angularity of 44.0 for HT and MT mixtures and 40.0 for ST mixtures when tested on combined aggregate in accordance with ASTM Designation: C1252 Method A. The 4.75 mm mixtures shall have a minimum fine aggregate angularity of 45.0 for all design levels when tested on combined aggregate in accordance with ASTM Designation: C 1252, Method A.

The minus No. 40 fraction of the combined aggregate shall be non-plastic when tested according to AASHTO Designation: T 90. The clay content for the combined aggregate for underlying layers shall not exceed 1.0 percent, and for the top layer shall not exceed 0.5 percent by weight of the total mineral aggregate when tested according to AASHTO Designation: T 88.

401.02.1.3--Bituminous Materials. Bituminous materials shall meet the applicable requirements of Section 702 for the grade specified.

Tack coat shall be the same neat grade asphalt cement used in the mixture being placed or those materials specified for tack coat in Table 410-A on the last page of Section 410. Emulsified asphalt shall not be diluted without approval of the Engineer.

401.02.1.4--Blank.

401.02.1.5--Hydrated Lime. Hydrated lime shall meet the requirements of Subsection 714.03.2 for lime used in soil stabilization.

401.02.1.6--Asphalt Admixtures. Additives for liquid asphalt, when required or permitted, shall meet the requirements of Subsection 702.08.

401.02.1.7--Polymers. Polymers for use in polymer modified HMA pavements shall meet the requirements of Subsection 702.08.3.

401.02.2--Blank.

401.02.3--Composition of Mixtures.

401.02.3.1--General. Unless otherwise specified or permitted, the HMA shall consist of a uniform mixture of asphalt, aggregate, hydrated lime and, when required or necessary to obtain desired properties, antistripping agent and/or other materials.

The total amount of crushed limestone aggregate for mixtures, excluding 4.75 mm mixtures, when used in the top lift, shall not exceed 50 percent of the total combined aggregate by weight.

Hydrated lime shall be used in all HMA at the rate of one percent (1%) by weight of the total dry aggregate including aggregate in RAP, if used. The aggregate, prior to the addition of the hydrated lime, shall contain sufficient surface moisture. If necessary, the Contractor shall add moisture to the aggregate according to the procedures set out in Subsection 401.03.2.1.2.

The Contractor shall obtain a shipping ticket for each shipment of hydrated lime. The Contractor shall provide the District Materials Engineer with a copy of each shipping ticket from the supplier, including the date, time and weight of hydrated lime shipped and used in hot mix asphalt production. An amount equal to twenty-five percent (25%) of the total value of HMA items performed during the initial estimate period in which the Contractor fails to submit the hydrated lime shipping tickets to the District Materials Engineer will be withheld from the Contractor's earned work. Non-conformance with this specification for successive estimate period(s) will result in the total value (100%) of HMA items performed during this period(s) being withheld from the Contractor's earned work. Monies withheld for this non-conformance will be released for payment on the next monthly estimate following the date the submittal of hydrated lime shipping tickets to the District Materials Engineer is brought back into compliance with this specification.

Mixtures will require the addition of an antistripping agent when the Tensile Strength Ratio (MT-63) and/or the Boiling Water Test (MT-59) fail to meet the following criteria.

Tensile Strength Ratio (TSR - MT-63)	
Wet Strength / Dry Strength	85 percent minimum
Interior Face Coating	95 percent minimum
Boiling Water Test (MT-59)	
Particle Coating	95 percent minimum

Reclaimed asphalt pavement (RAP) materials may be used in the production of HMA in the percentages of the total mix by weight set out in the following table:

HMA Mixture	Maximum percent RAP by total weight of mix
4.75 mm	0
9.5 mm	15
12.5 mm Top Lift	15
12.5 mm Underlying Lift	30
19 mm	30
25 mm	30

During HMA production, the RAP shall pass through a maximum 2-inch square sieve located in the HMA plant after the RAP cold feed bin and prior to the RAP weighing system.

Crushed reclaimed concrete pavement may be used as an aggregate component of all HMA pavements. When crushed reclaimed concrete pavement is used as an aggregate component, controls shall be implemented to prevent segregation. Crushed reclaimed concrete pavement aggregate shall be separated into coarse and fine aggregate stockpiles using the 3/8-in or 1/2-in sieve as a break-point unless otherwise approved by the Engineer in writing.

401.02.3.1.1--Mixture Properties.

<u>ALL MIXTURES</u>	<u>Percent of Maximum Specific Gravity (Gmm)</u>
N _{Design}	96.0
N _{Initial}	Less than 90.0
N _{Maximum}	Less than 98.0
<u>VMA CRITERIA</u>	<u>Minimum percent</u>
25-mm mixture	12.0
19-mm mixture	13.0
12.5-mm mixture	14.0
9.5-mm mixture	15.0
4.75 mm mixture	16.0

Mixtures with VMA more than two percent higher than the minimum may be susceptible to flushing and rutting; therefore, unless satisfactory experience with

high VMA mixtures is available, mixtures with VMA greater than two percent above the minimum should be avoided.

The specified VFA range for 4.75 mm nominal maximum size mixtures for design traffic levels >3 million ESAL’s (HT Mixtures) shall be 75 to 78 percent, for design traffic levels of 1.0 to 3 million ESAL’s (MT mixtures) 65 to 78 percent, and for design traffic levels of <1.0 million ESAL’s (ST mixtures) 65 to 78 percent.

DUST/BINDER RATIO for 4.75 mm mixtures

Percent Passing No.200 / Effective Binder Percent 0.9 to 2.0

DUST/BINDER RATIO for 9.5 mm, 12.5 mm, 19 mm & 25mm mixtures

Percent Passing No.200 / Effective Binder Percent 0.8 to 1.6

401.02.3.2--Job Mix Formula. The job mix formula shall be established in accordance with Mississippi Test Method: MT-78, where N represents the number of revolutions of the gyratory compactor.

Compaction Requirements:	N _{Initial}	N _{Design}	N _{Maximum}
High Type (HT) Mixtures			
19 mm, 12.5 mm, 9.5 mm & 4.75 mm	7	85	130
Medium Type (MT) Mixtures			
19 mm, 12.5 mm, 9.5 mm & 4.75 mm	7	65	100
All Standard Type (ST) Mixtures;			
25 mm HT & MT Mixtures	6	50	75

At least 10 working days prior to the proposed use of each mixture, the Contractor shall submit in writing to the Engineer a proposed job-mix formula or request the transfer of a verified job-mix formula as set forth in the latest edition of MDOT’s Field Manual for HMA and SOP TMD-11-78-00-000. The job-mix formula shall be signed by a Certified Mixture Design Technician (CMDT).

The Department will perform the tests necessary for review of a proposed job-mix formula for each required mixture free of charge one time only. A charge will be made for additional job-mix formulas submitted by the Contractor for review.

Review of the proposed job-mix formula will be based on percent maximum specific gravity at N_{Initial}, N_{Design}, and N_{Maximum}, VMA @ N_{Design}, resistance to stripping, and other criteria specified for the mixture.

The mixture shall conform thereto within the range of tolerances specified for the particular mixture. No change in properties or proportion of any component of

the job-mix formula shall be made without permission of the Engineer. The job-mix formula for each mixture shall be in effect until revised in writing by the Engineer.

A job-mix formula may be transferred to other contracts in accordance with conditions set forth in the Department's Field Manual for HMA.

The Contractor shall not place any HMA prior to receiving “tentative” approval and a MDOT design number from the Central Laboratory.

When a change in source of materials, unsatisfactory mixture production results (such as segregation, bleeding, shoving, rutting over 1/8”, raveling & cracking) or changed conditions make it necessary, a new job-mix formula will be required. The conditions set out herein for the original job-mix formula are applicable to the new job-mix formula.

401.02.4--Substitution of Mixture. The substitution of a one (1) size finer mixture for an underlying lift shall require written permission of the State Construction Engineer, except no substitution of a 4.75 mm mixture will be allowed. A 9.5 mm mixture may be substituted for the 12.5 mm mixture designated on the plans as the top lift or pre-leveling. The 19 mm mixture may be substituted for the 25 mm mixture in trench widening work. Any substitution of mixtures shall be of the same type. No other substitutions will be allowed. The quantity of substituted mixture shall be measured and paid for at the contract unit price for the mixture designated on the plans. The substitution of any mixture will be contingent on meeting the required total structure thickness and maintaining the minimum and/or maximum laying thickness for the particular substituted mixture as set out in the following table.

Mixture	Single Lift Laying Thickness Inches	
	Minimum	Maximum
25 mm	3	4
19 mm	2 1/4	3
12.5 mm	1 1/2	2
9.5 mm	1	1 1/2
4.75 mm	1/2	3/4

401.02.5--Contractor's Quality Management Program.

401.02.5.1--General. The Contractor shall have full responsibility for quality management and maintain a quality control system that will furnish reasonable assurance that the mixtures and all component materials incorporated in the work conform to contract requirements. The Contractor shall have responsibility for the initial determination and all subsequent adjustments in proportioning

materials used to produce the specified mixture. Adjustments to plant operation and spreading and compaction procedures shall be made immediately when results indicate that they are necessary. Mixture produced by the Contractor without the required testing or personnel on the project shall be subject to removal and replacement by the Contractor at no additional cost to the State.

401.02.5.2--Personnel Requirements. The Contractor shall provide at least one Certified Asphalt Technician-I (CAT-I) full-time during HMA production at each plant site used to furnish material to the project. Sampling shall be conducted by a certified technician or by plant personnel under the direct observation of a certified technician. All testing, data analysis and data posting will be performed by the CAT-I or by an assistant under the direct supervision of the CAT-I. The Contractor shall have a Certified Asphalt Technician-II (CAT-II) available to make any necessary process adjustments. Technician certification shall be in accordance with MDOT SOP TMD-22-10-00-000, MDOT HMA Technician Certification Program. An organizational chart, including names, telephone numbers and current certification, of all those responsible for the quality control program shall be posted in the Contractor's laboratory while the asphaltic paving work is in progress.

401.02.5.3--Testing Requirements. As a minimum, the Contractor's quality management program shall include the following:

- (a) Bituminous Material. Provide Engineer with samples in a sealed one quart metal container at the frequency given in MDOT SOP TMD-20-04-00-000.
- (b) Mechanically Fractured Face. Determine mechanically fractured face content of aggregates retained on the No. 4 sieve, at a minimum of one test per day of production.
- (c) Mixture Gradation. Conduct extraction tests for gradation determination on the mixture. Sample according to the frequency in paragraph (i) and test according to Mississippi Test Method MT-31.
- (d) Total Voids and VMA. Determine total voids and voids in mineral aggregate (VMA), at N_{Design} , from the results of bulk specific gravity tests on laboratory compacted specimens. Sample according to the sampling frequency in paragraph (i) and test according to the latest edition of MDOT's Field Manual for HMA.
- (e) Asphalt Content. Sample according to the sampling frequency in paragraph (i). Determine the asphalt content using one of the following procedures.
 - (1) Nuclear gauge per Mississippi Test Method MT-6.
 - (2) Incinerator oven per AASHTO Designation: T 308, Method A.

- (f) Stripping Tests. Conduct a minimum of one stripping test at the beginning of each job-mix production and thereafter, at least once per each two weeks of production according to Mississippi Test Method: MT-63 and one stripping test per day of production according to Mississippi Test Method: MT-59. Should either the TSR (MT-63) or the boiling water (MT-59) stripping tests fail, a new antistrip additive or rate shall be established or other changes made immediately that will result in a mixture which conforms to the specifications; otherwise, production shall be suspended until corrections are made.
- (g) Density Tests. For 25 mm, 19.5 mm, 12.5 mm & 9.5 mm mixtures, conduct density tests as necessary to control and maintain required compaction according to Mississippi Test Method: MT-16, Method C (nuclear gauge), or AASHTO Designation: T 166. Note - The nuclear gauge may be correlated, at the Contractor's option, with the average of a minimum of five pavement sample densities. For 4.75 mm mixtures, conduct density tests as necessary to control and maintain required compaction according to AASHTO Designation: T 166.
- (h) Quality Control Charts. Plot the individual test data, the average of the last four tests and the control limits for the following items as a minimum:

Mixture Gradation (Percent Passing) Sieves:

1/2-in, 3/8-in, No. 8, No. 16, No. 30 and No. 200.

Asphalt Content, Percent

Maximum Specific Gravity, G_{mm}

Total Voids @ N_{Design} , Percent

VMA @ N_{Design} , Percent

NOTE: For 4.75 mm mixtures, Quality Control Charts for mixture gradation are not required on the No. 8 and No. 30 sieves. For 4.75 mm mixtures, as a minimum, Quality Control Charts for mixture gradation shall be kept on the 3/8-in, No. 16 and No. 200 sieves. For all mixtures other than 4.75 mm, Quality Control Charts for mixture gradation are not required on the No. 16 sieve.

Keep charts up-to-date and posted in a readily observable location. Charts may be kept on a computer, however, the charts shall be printed out a minimum of once each production day and displayed in the laboratory. Note any process changes or adjustments on the Air Voids chart.

- (i) Sampling Frequency. Conduct those tests as required above at the following frequency for each mixture produced based on the estimated

plant tonnage at the beginning of the day.

<u>Total Estimated Production, tons</u>	<u>Number of Tests</u>
50-800	1
801-1700	2
1701-2700	3
2701+	4

NOTE: Material placed in a storage silo from a previous day's production shall be randomly sampled and tested when removed for placement on the roadway. Such sample(s) shall be independent of the day's production sampling frequency and shall be used in calculating the four (4) sample running average.

- (j) **Sample Requirements.** Obtain the asphalt mixture samples from trucks at the plant. Obtain aggregate samples from cold feed bins or aggregate stockpile. Save a split portion of all mixture samples at the laboratory site in a dry and protected location for 14 calendar days. At the completion of the project, the remaining samples may be disposed of with the approval of the Engineer.

The above testing frequencies are for the estimated plant production for the day. If production is discontinued or interrupted, the tests will be conducted at the previously established sample tonnage points for the materials that are actually produced. If the production exceeds the estimated tonnage, sampling and testing will continue at the testing increments previously established for the day. A testing increment is defined as the estimated daily tonnage divided by the required number of tests from the table in Subsection 401.02.5.3 paragraph (i).

In addition to the above program, the following tests shall be conducted on the first day of production and once for every eight production samples thereafter, with a minimum of one test per production week.

Aggregate Stockpile Gradations per AASHTO Designations: T-11 and T-27.

Reclaimed Asphalt Pavement (RAP) Gradation per Mississippi Test Method MT-31.

Fine Aggregate Angularity for all 4.75 mm and 9.5 mm mixtures and all MT and HT mixtures designed above the maximum density line per ASTM Designation: C 1252, Method A.

Testing of the aggregate and RAP stockpiles during production will be waived provided the Contractor provides the Engineer with gradation test results for the materials in the stockpile determined during the building of the stockpiles. The test results provided shall represent a minimum frequency of one per one

thousand tons of material in the stockpile. If the Contractor continues to add materials to the stockpile during HMA production, the requirements for gradation testing during production are not waived.

401.02.5.4--Documentation. The Contractor shall document all observations, records of inspection, adjustments to the mixture, and test results on a daily basis. All tests conducted by the Contractor in accordance with Subsection 401.02.5.3(h) shall be included in the running average calculations. If single tests are performed as a check on individual HMA properties, between regular samples, without performing all tests required in Subsection 401.02.5.3(h), the results of those individual tests shall not be included in the running average calculations for that particular property. The Contractor shall record the results of observations and records of inspection as they occur in a permanent field record. The Contractor shall record all process adjustments and job mix formula (JMF) changes on the air void charts. The Contractor shall provide copies of all test data sheets and the daily summary reports on the appropriate Mississippi DOT forms to the Engineer on a daily basis. The Contractor shall provide a written description of any process change, including blend proportions, to the Engineer as they occur. Information provided to the Engineer must be received in the Engineer’s office by no later than 9:00 AM the day after the HMA is produced. Fourteen days after the completion of the placement of the HMA, the Contractor shall provide the Engineer with the original testing records and control charts in a neat and orderly manner.

401.02.5.5--Control Limits. The following control limits for the job mix formula (JMF) and warning limits are based on a running average of the last four data points.

<u>Item</u>	<u>JMF Limits</u>	<u>Warning Limits</u>
Sieve - % Passing		
1/2-in	± 5.5	± 4.0
3/8-in	± 5.5	± 4.0
No. 8	± 5.0	± 4.0
No. 16, for 4.75 mm mixtures ONLY	± 4.0	± 3.0
No. 30	± 4.0	± 3.0
No. 200	± 1.5	± 1.0
Asphalt Content, %	-0.3 to +0.5	-0.2 to + 0.4
Total Voids @ N _{Design} , %	± 1.3	± 1.0
VMA @ N _{Design} , %	- 1.5	- 1.0

401.02.5.6--Warning Bands. Warning bands are defined as the area between the JMF limits and the warning limits.

401.02.5.7--Job Mix Formula Adjustments. A request for a JMF adjustment signed by a CAT-II may be made to the Engineer by the Contractor. Submit sufficient testing data with the request to justify the change. The requested

change will be reviewed by the State Materials Engineer for the Department. If current production values meet the mixture design requirements, a revised JMF will be issued. Adjustments to the JMF shall conform to the latest edition of MDOT's Field Manual for HMA. Adjustments to the JMF to conform to actual production shall not exceed the tolerances specified for the JMF limits. Regardless of such tolerances, any adjusted JMF gradation shall be within the design master range for the mixture specified. The JMF asphalt content may only be reduced if the production VMA meets or exceeds the minimum design VMA requirements for the mixture being produced.

401.02.5.8--Actions and Adjustments. Based on the process control test results for any property in question, the following actions shall be taken or adjustments made when appropriate:

- (a) When the running average trends toward the warning limits, the Contractor shall consider taking corrective action. The corrective action, if any, shall be documented. All tests shall be part of the contract files and shall be included in the running average calculations.
- (b) The Contractor shall notify the Engineer whenever the running average exceeds the warning limits.
- (c) If two consecutive running averages exceed the warning limit, the Contractor shall stop production and make adjustments. Production shall only be restarted after notifying the Engineer of the adjustments made.
- (d) If the adjustment made under (c) improves the process such that the running average after four additional tests is within the warning limits, the Contractor may continue production with no reduction in payment.
- (e) If the adjustment made under (c) does not improve the process and the running average after four additional tests stays in the warning band, the mixture will be considered unsatisfactory. Reduced payment for unsatisfactory mixtures will be applied starting from the stop point to the point when the running average is back within the warning limits in accordance with Subsection 401.02.6.3.
- (f) Failure to stop production and make adjustments when required shall subject all mixture produced from the stop point to the point when the running average is back within the warning limits to be considered unsatisfactory. Reduced payment for unsatisfactory mixtures will be applied in accordance with Subsection 401.02.6.3.
- (g) If the running average exceeds the JMF limits, the Contractor shall stop production and make adjustments. Production shall only be restarted after notifying the Engineer of the adjustments made.
- (h) All materials for which the running average exceeds the JMF limits will be considered unacceptable and shall be removed and replaced by the Contractor at no additional cost to the State. The Engineer will determine the quantity of material to be replaced based on a review of the individual testing data which make up the running average in question and an inspection of the completed pavement. If the Engineer decides to

leave the mixture in place because of special circumstances, the quantity of mixture, as defined above, will be paid for in accordance with Subsection 401.02.6.3.

- (i) Single test results shall be compared to 1.7 times the warning and JMF limits. If the test results verified by QA testing (within allowable differences in Subsection 401.02.6.2) exceed these limits, the pay factor provided in Subsection 401.02.6.3 will apply for the quantity of material represented by the test(s). Single test limits will be used for the acceptance of projects when insufficient tonnage is produced to require four (4) Contractor's tests.
- (j) The above corrective action will also apply for a mixture when the Contractor's testing data has been proven incorrect. The Contractor's data will be considered incorrect when; 1) the Contractor's tests and the Engineer's tests do not agree within the allowable differences given in Subsection 401.02.6.2 and the difference can not be resolved, or 2) the Engineer's tests indicates that production is outside the JMF limits and the results have been verified by the Materials Division. The Engineer's data will be used in place of the Contractor's data to determine the appropriate pay factor.

401.02.6--Standards of Acceptance.

401.02.6.1--General. Acceptance for mixture quality (VMA and total voids @ N_{Design} , gradation, and asphalt content) will be based on random samples tested in accordance with the latest edition of MDOT's Field Manual for HMA. Pavement densities and smoothness will be accepted by lots as set out in Subsections 401.02.6.4 and 401.02.6.5.

401.02.6.2--Assurance Program for Mixture Quality. The rounding of test results will be in accordance with Subsection 700.04.

The Engineer will conduct assurance tests on split samples taken by the Contractor. These samples may be the regular quality management samples or a sample chosen by the Engineer anytime during production. The frequency will be equal to or greater than ten percent of the tests required for the Contractor quality control and the data will be provided to the Contractor within two asphalt mixture production days after the sample has been obtained by the Engineer. At least one sample shall be tested from the first two days of production. The Engineer may select any or all of the Contractor retained samples for assurance testing. All testing and data analysis shall be performed by a Certified Asphalt Technician-I (CAT-I) or by an assistant under the direct supervision of the CAT-I. Certification shall be in accordance with MDOT SOP TMD-22-10-00-000, MDOT HMA Technician Certification Program. The Department shall post a chart giving the names and telephone numbers for the personnel responsible for the assurance program.

The Engineer shall be allowed to inspect measuring and testing devices to confirm

both calibration and condition. The Contractor shall calibrate and correlate all testing equipment in accordance with the latest version of the Department's Test Methods.

Random differences between the Contractor's and Engineer's split sample test results will be considered acceptable if within the following limits:

Item	Allowable Differences
Sieve - % Passing	
3/8-in and above	6.0
No. 4	5.0
No. 8	4.0
No. 16, for 4.75 mm mixtures ONLY	3.5
No. 30	3.5
No. 200	2.0
AC Content	0.4
Specimen Bulk SG, Gmb @ N _{Design}	0.030
Maximum SG, Gmm	0.020

In the event that; 1) the comparison of the Contractor's and Engineer's test results are outside the allowable differences in the above table, or 2) if a bias exists between the results, such that one of the results is predominately higher or lower than the other, and the Engineer's results fail to meet the JMF control limits, the Engineer will investigate the reason immediately. The Engineer's investigation may include testing of the remaining split samples, review and observation of the Contractor's testing procedures and equipment, and a comparison of split sample test results by the Contractor quality control laboratory, Department quality assurance laboratory and the Materials Division. The procedures outlined in the latest edition of MDOT's Field Manual for HMA may be used as a guide for the investigation. In the event that the Contractor's results are determined to be incorrect, the Engineer's results will be used for the quality control data and the appropriate payment for the mixture will be based on the procedures specified in Subsection 401.02.5.8(j).

The Engineer will periodically witness the sampling and testing being performed by the Contractor. The Engineer, both verbally and in writing, will promptly notify the Contractor of any observed deficiencies. When differences exist between the Contractor and the Engineer which cannot be resolved, a decision will be made by the State Materials Engineer, acting as the referee, and will in writing promptly notify the Contractor. If the deficiencies are not corrected, the Engineer will stop production until corrective action is taken.

401.02.6.3--Acceptance Procedure for Mixture Quality. All obviously defective material or mixture will be subject to rejection by the Engineer. Such defective material or mixture shall not be incorporated into the finished work. If the defective material has already been placed in the work, the material shall be removed and replaced at no additional cost to the State.

The Engineer will base final acceptance of the asphalt mixture production on the results of the Contractor's testing for total voids and VMA @ N_{Design} , gradation, and asphalt content as verified by the Engineer in the manner hereinbefore described and the uniformity and condition of the completed pavement. Areas of pavement that exhibit non-uniformity or failures, materials or construction related, such as but not limited to segregation, bleeding, shoving, rutting over $\frac{1}{8}$ ", raveling, slippage, or cracking will not be accepted. Such areas will be removed and replaced at no additional cost to the State.

Bituminous mixture placed prior to correction for deficiencies in VMA and total voids @ N_{Design} , gradation, or asphalt content, as required in Subsection 401.02.5.8 and determined by the Engineer satisfactory to remain in place will be paid for in accordance with the following pay factors times the contract unit price per ton.

Pay Factor for Mixture Quality *

Item	Produced in Warning Bands	Produced Outside JMF Limits, Allowed to Remain in Place
Gradation	0.90	0.75
Asphalt Content	0.85	0.75
Total Voids @ N_{Design}	0.70	0.50
VMA @ N_{Design}	0.90	0.75

* The minimum single payment will apply.

401.02.6.4--Acceptance Procedure for Density. Each completed lift will be accepted with respect to compaction on a lot to lot basis from density tests performed by the Department. For normal production days, divide the production into approximately equal lots as shown in the following table. When cores are being used for the compaction evaluation, randomly obtain one core from each lot. When the nuclear density gauge is being used for compaction evaluation, obtain two random readings from each lot and average the results. See Chapter 7 of the latest edition of MDOT's Field Manual for HMA for more details. Additional tests may be required by the Engineer to determine acceptance of work appearing deficient. The Contractor shall furnish and maintain traffic control for all compaction evaluations, including coring, required in satisfying specified density requirements.

Lot Determination

<u>Daily Production - Tons</u>	<u>Number of Lots</u>
0-300	1
301-600	2
601-1000	3
1001-1500	4
1501-2100	5
2101-2800	6
2801+	7

401.02.6.4.1--Roadway Density. The density requirement for each completed lift on a lot to lot basis from density tests performed by the Department shall be as follows:

1. For all single lift overlays, with or without leveling and/or milling, the required lot density shall be 92.0 percent of maximum density.
2. For all multiple lift overlays of two (2) or more lifts excluding leveling lifts, the required lot density of the bottom lift shall be 92. 0 percent of maximum density. The required lot density for all subsequent lifts shall be 93.0 percent of maximum density.
3. For all pavements on new construction, the required lot density for all lifts shall be 93.0 percent of maximum density.

When it is determined that the density for a lot is below the required density (93.0 percent or 92.0 percent) but not lower than 91.0 or 90.0 percent of maximum density, respectively, the Contractor will have the right to remove and replace the lot(s) not meeting the specified density requirements in lieu of accepting reduced payment for the lot(s).

When it is determined that the density for a lot is above 96.0 percent, the Engineer shall notify the Contractor who will make plant adjustments to resolve the problem.

When it is determined that the density for a lot is below 91.0 or 90.0 percent, respectively, the lot(s), or portions thereof shall be removed and replaced in accordance with Chapter 7 of the latest edition of MDOT’s Field Manual for HMA at no additional cost to the State. A corrected lot will be retested for approval. No resampling will be performed when pavement samples are used for determining density.

At any time the average daily compaction (the total of the percent compaction for the lots produced in one day divided by the total number of lots for the day) does not meet the required percent compaction or more for two consecutive days, the

Contractor shall notify the Engineer of proposed changes to the compactive effort. If the average daily compaction does not meet the required percent compaction or more for a third consecutive day, the Contractor shall stop production until compaction procedures are established to meet the specified density requirements.

Each lot of work found not to meet the density requirement of 92.0% or 93% of maximum density, respectively, may remain in place with a reduction in payment as set out in the following tables:

**PAYMENT SCHEDULE FOR COMPACTION
OF 92.0 PERCENT OF MAXIMUM DENSITY**

<u>Pay Factor</u>	<u>Lot Density ** % of Maximum Density</u>
1.00	92.0 and above
0.90	91.0 - 91.9
0.70	90.0 - 90.9

** Any lot or portion thereof with a density of less than 90.0 percent of maximum density shall be removed and replaced at no additional cost to the State.

**PAYMENT SCHEDULE FOR COMPACTION
OF 93.0 PERCENT OF MAXIMUM DENSITY**

<u>Pay Factor</u>	<u>Lot Density *** % of Maximum Density</u>
1.00	93.0 and above
0.90	92.0 - 92.9
0.70	91.0 - 91.9

*** Any lot or portion thereof with a density of less than 91.0 percent of maximum density shall be removed and replaced at no additional cost to the State.

The compaction pay factors and mixture quality pay factor, as described in Subsection 401.02.6.3, will each apply separately. However, the combined pay factor shall not be less than 0.50 for any mixture allowed to remain in place.

401.02.6.4.2--Trench Widening Density. The density for trench widening on a lot to lot basis shall be determined from density tests performed by the Department using pavement samples (cores).

When it is determined that the density for a trench widening lot is below 89.0 percent but not lower than 88.0 percent of maximum density, the Contractor will

have the right to remove and replace the lot(s) not meeting the specified density requirements in lieu of accepting reduced payment for the lot(s).

When it is determined that the density for a trench widening lot is above 95.0 percent, the Engineer shall notify the Contractor who will make plant adjustments to resolve the problem.

When it is determined that the density for a trench widening lot is below 88.0 percent, the lot(s), or portions thereof shall be removed and replaced in accordance with Chapter 7 of the latest edition of MDOT’s Field Manual for HMA at no additional cost to the State. A corrected lot will be retested for approval. No resampling will be performed when pavement samples are used for determining density.

At any time the daily compaction (the total of the percent compaction for the lots produced in one day divided by the total number of lots for the day) does not meet 89.0 percent compaction or more for two consecutive days, the Contractor shall notify the Engineer of proposed changes to the compactive effort. If the average daily compaction does not meet 89.0 percent compaction or more for a third consecutive day, the Contractor shall stop production until compaction procedures are established to meet the specified density requirement.

Each lot of trench widening work found not to meet the density requirement of 91.0 percent of maximum density may remain in place with a reduction in payment as set out in the following table:

**PAYMENT SCHEDULE FOR COMPACTION
TRENCH WIDENING WORK**

<u>Pay Factor</u>	<u>Lot Density *** % of Maximum Density</u>
1.00	89.0 and above
0.50	88.0 - 88.9

*** Any lot or portion thereof with a density of less than 88.0 percent of maximum density shall be removed and replaced at no additional cost to the State.

The compaction pay factors and mixture quality pay factor, as described in Subsection 401.02.6.3, will each apply separately. However, the combined pay factor shall not be less than 0.50 for any mixture allowed to remain in place.

401.02.6.5--Acceptance Procedure for Pavement Smoothness. When compaction is completed, the lift shall have a uniform surface and be in reasonably close conformity with the line, grade and cross section shown on the plans.

The smoothness of each applicable lift will be determined by using a California Profilograph to produce a profilogram (profile trace) at each designated location. The surface shall be tested and corrected to a smoothness index as described herein with the exception of those locations or specific projects that are excluded from a smoothness test with the profilograph.

The profilograph, furnished and operated by the Contractor under supervision of the Engineer, shall consist of a frame at least 25 feet in length supported upon multiple wheels having no common axle. The wheels shall be arranged in a staggered pattern so that no two wheels will simultaneously cross the same bump. A profile is to be recorded from the vertical movement of a sensing mechanism. This profile is in reference to the mean elevation of the contact points established by the support wheels. The sensing mechanism, located at the mid-frame, may consist of a single bicycle-type wheel or a dual-wheel assembly consisting of either a bicycle-type (pneumatic tire) or solid rubber tire vertical sensing wheel and a separate bicycle-type (pneumatic tire) longitudinal sensing wheel. The wheel(s) shall be of such circumference(s) to produce a profilogram recorded on a scale of one (1) inch equal to 25 feet longitudinally and one (1) inch equal to one (1) inch (full scale) vertically. Motive power may be provided manually or by the use of a propulsion unit attached to the center assembly. In operation, the profilograph shall be moved longitudinally along the pavement at a speed no greater than 3 MPH so as to reduce bounce as much as possible. The testing equipment and procedure shall comply with the requirements of Department SOP.

The Contractor may elect to use a computerized version of the profilograph in lieu of the standard profilograph. If the computerized version of the profilograph is used, it shall meet the requirements of Subsection 401.02.6.6.

The smoothness of each applicable lift will be determined for traffic lanes, auxiliary lanes, climbing lane and two-way turn lanes. Areas excluded from a smoothness test with the profilograph are acceleration and deceleration lanes, tapered sections, transition sections for width, shoulders, crossovers, ramps, side street returns, etc. The roadway pavement on bridge replacement projects having 1,000 feet or less of pavement on each side of the structure will be excluded from a test with the profilograph. Pavement on horizontal curves having a radius of less than 1,000 feet at the centerline and pavement within the superelevation transition of such curves are excluded from a test with the profilograph. The profilogram shall terminate 15 feet from each transverse joint that separates the pavement from a bridge deck, bridge approach slab or existing pavement not constructed under the contract.

A profilogram will be made for each applicable lift. The measurements will be made in the outside wheel path of exterior lanes and either wheel path of interior lanes. The wheel path is designated as being located three feet from the edge of pavement or longitudinal joint. The testing will be limited to a single

profilogram for each lift of a lane except that a new profilogram will be made on segments that have been surface corrected. When surface corrections are required and/or made, a new profilogram will be made. The new profilogram shall meet the requirements of Subsection 403.03.2.

Each applicable lift will be accepted on a segment to segment basis for pavement smoothness. Where the profile index requirement of the lift is 30.0 inches per mile, no segment of the lift with a profile index greater than 30.0 inches per mile shall be allowed to remain in place without correction. For the purpose of determining pavement smoothness and contract price adjustment for rideability as described in Subsection 403.03.2, each day's production will be sub-divided into sections which terminate at bridges, transverse joints or other interruptions. Each section will be sub-divided into segments of 528 feet. Where a segment less than 528 feet occurs at the end of a section, it will be combined with the preceding 528-foot segment for calculation of the profile index. The last 15 feet of a day's lift may not be obtainable until the lift is continued and for this reason may be included in the subsequent segment.

A profile index will be determined for each segment as inches per mile in excess of the "Zero" blanking band which is simply referred to as the "Profile Index". From the profilogram of each segment, the scallops above and below the "Zero" blanking band are totaled in tenths of an inch. The totaled count of tenths is converted to inches per mile to establish a smoothness profile index for that segment.

Individual bumps and/or dips that are identified on the profilogram by locating vertical deviations that exceed four tenths of an inch when measured from a chord length of 25 feet or less shall be corrected regardless of the profile index value of the segment. Surface correction by grinding shall be in accordance with Subsection 401.02.6.7. The Contractor shall also make other necessary surface corrections to ensure that the final profile index of the segment meets the requirements of Subsection 403.03.2.

Segment(s) exceeding the accepted profile index value shall be corrected as specified in Subsection 403.03.4. All such corrections shall be at the expense of the Contractor.

Scheduling will be the responsibility of the Contractor with approval of the Engineer, and the tests shall be conducted within 72 hours after each day's production unless authorized otherwise by the Engineer. The Contractor will be responsible for traffic control associated with this testing operation.

401.02.6.6--Computerized Profilograph.

401.02.6.6.1--General The computerized profilograph, furnished and operated by the Contractor under the supervision of the Engineer, shall be equipped with an on-board computer capable of meeting the following conditions.

Vertical displacement shall be sampled every three (3) inches or less along the roadway. The profile data shall be bandpass filtered in the computer to remove all spatial wavelengths shorter than two (2) feet. This shall be accomplished by a third order, low pass Butterworth filter. The resulting band limited profile will then be computer analyzed according to the California Profilograph reduction process to produce the required inches per mile index. This shall be accomplished by fitting a linear regression line to each 528 feet of continuous pavement section. This corresponds to the perfect placement of the blanking band bar by a human trace reducer. Scallops above and below the blanking band are then detected and totaled according to the California protocol. Bump/Dip analysis shall take place according to the California Profilograph reduction process.

The computerized profilograph shall be capable of producing a plot of the profile and a printout which will give the following data: Stations every twenty five (25) feet, bump/dip height and bump/dip length of specification (4/10 of an inch and 25 feet respectively), the blanking band width, date of measurement, total profile index in inches per mile for the measurement, total length of the measurement, and the raw inches for each tenth mile segment.

401.02.6.6.2--Mechanical Requirements. The profilograph shall consists of a frame twenty five (25) feet long supported at each end by multiple wheels. The frame shall be constructed to be easily dismantled for transporting. The profilograph shall be constructed from aluminum, stainless steel and chromed parts. The end support wheels shall be arranged in a staggered pattern such that no two wheels cross a transverse joint at the same time. The relative smoothness shall be measured by the vertical movement of an eight (8) inch or larger diameter sensing wheel at the midpoint of the 25-foot frame. The horizontal distance shall be measured by a twenty (20) inch or larger diameter pneumatic wheel. This profile shall be the mean elevation referenced to the twelve points of contact with the pavement established by the support wheels. Recorded graphical trace of the profile shall be on a scale of one inch equals one inch (full scale) vertical motion of the sensing wheel and one inch equals 25 feet horizontal motion of the profilograph.

401.02.6.6.3--Computer Requirements. The computer shall have the ability to produce output on sight for verification. The computerized output shall indicate the profile index for each specified section of roadway. Variable low and high pass third-order Butterworth filtering options shall be available. The printout shall be capable of showing station marks automatically on the output. Blanking band positioning for each specified section of the roadway shall be placed according to the least squares fit line of the collected data. Variable bump and dip tests shall be available to show "must correct" locations on the printout. The computer must have the ability to display on screen "must correct" conditions and alert the user with an audible warning when a "must correct" location has been located. The computer must have the ability to store profile data for later

reanalysis. The measurement program must be menu driven and IBM compatible. User selected options, identification, calibration factors, and time and date stamps shall be printed at the top of each printed report for verification. The control software must be upgradeable. A power source shall be included for each profilograph and be capable of supplying all power needs for a full days testing.

401.02.6.7--Surface Correction. Corrective work to bumps shall consist of diamond grinding in accordance with these specifications or methods approved by the Engineer. All surface areas corrected by grinding shall be sealed with a sealant approved by the Engineer.

401.02.6.7.1--Diamond Grinding. Grinding of asphalt surfaces shall consist of diamond grinding the existing asphalt pavement surface to remove surface distortions to achieve the specified surface smoothness requirements.

401.02.6.7.2--Equipment. The grinding equipment shall be a power driven, self-propelled machine that is specifically designed to smooth and texture pavement surfaces with diamond blades. The effective wheel base of the machine shall not be less than 12.0 feet. It shall have a set of pivoting tandem bogey wheels at the front of the machine and the rear wheels shall be arranged to travel in the track of the fresh cut pavement. The center of the grinding head shall be no further than 3.0 feet forward from the center of the back wheels.

The equipment shall be of a size that will cut or plane at least 2.0 feet wide. It shall also be of a shape and dimension that does not encroach on traffic movement outside of the work area. The equipment shall be capable of grinding the surface without causing spalls at joints, or other locations.

401.02.6.7.3--Construction. The construction operation shall be scheduled and proceed in a manner that produces a uniform finish surface. Grinding will be accomplished in a manner to provide positive lateral drainage by maintaining a constant cross-slope between grinding extremities in each lane.

The operation shall result in pavement that conforms to the typical cross-section and the requirements specified in Subsection 401.02.6.7.4. It is the intent of this specification that the surface smoothness characteristics be within the limits specified.

The Contractor shall establish positive means for removal of grinding residue. Solid residue shall be removed from pavement surfaces before it is blown by traffic action or wind. Residue shall not be permitted to flow across lanes used by public traffic or into gutters or drainage facilities, but may be allowed to flow into adjacent ditches.

401.02.6.7.4--Finished Pavement Surface. The grinding process shall produce

a pavement surface that is smooth and uniform in appearance with a longitudinal line type texture. The line type texture shall contain parallel longitudinal corrugations that present a narrow ridge corduroy type appearance. The peaks of the ridges shall not be more than 1/16 inch higher than the bottoms of the grooves.

The finished pavement surface will be measured for riding quality. The grinding shall produce a riding surface which does not exceed either the specified profile index or the specified bump and dip limit.

401.02.7--Nuclear Gauges.

401.02.7.1--Nuclear Moisture-Density Gauge. The nuclear gauge unit used to monitor density shall contain a full data processor which holds all calibration constants necessary to compute and directly display wet density, moisture, and dry density in pounds per cubic foot. The data processor shall compute and display the percent moisture and percent density based on dry weight.

401.02.7.2--Nuclear Asphalt Content Gauge. The Contractor shall furnish and calibrate, unless designated otherwise in the contract, a Troxler Nuclear Asphalt Content Gauge Model 3241 or updated model, or a Campbell Nuclear Asphalt Content Gauge Model AC-2 or an approved equal.

401.03--Construction Requirements. Mississippi DOT has adopted the “Hot-Mix Asphalt Paving Handbook” as the guideline for acceptable HMA construction practices.

401.03.1--Specific Requirements.

401.03.1.1--Weather Limitations. The mixture shall not be placed when weather conditions prevent the proper handling and finishing or the surface on which it is to be placed is wet or frozen. At the time of placement, the air and pavement surface temperature limitations shall be equal to or exceed that specified in the following table:

TEMPERATURE LIMITATIONS

Compacted Thickness	Temperature
Less than 1½ inches	55°F
1½ inches to 2 inches	50°F
2¼ inches to 3 inches	45°F
Greater than 3 inches	40°F

When paving operations are discontinued because of rain, the mixture in transit shall be protected until the rain ceases. The surface on which the mixture is to be placed shall be swept to remove as much moisture as possible and the mixture

may then be placed subject to removal and replacement at no additional cost to the State if contract requirements are not met.

401.03.1.2--Tack Coat. Tack coat shall be applied to previously placed HMA and between lifts, unless otherwise directed by the Engineer. The tack coat shall be applied as a spray coating, fog coating, or "spider webbing". Construction requirements shall be in accordance with Subsection 407.03.

401.03.1.3--Blank.

401.03.1.4--Density. The lot density for all dense graded pavement lifts, except as provided below for preleveling, wedging [less than fifty percent (50%) of width greater than minimum lift thickness], ramp pads, irregular shoulder areas, median crossovers, turnouts, or other areas where the established rolling pattern cannot be performed, shall not be less than 92.0 percent of the maximum density based on AASHTO Designation: T 209 for the day's production. If a job-mix formula adjustment is made during the day which affects the maximum specific gravity, calculate a new average maximum density for the lot(s) placed after the change.

Pavement core samples obtained for determining density which have a thickness less than two times the maximum size aggregate permitted by the job-mix formula will not be used as a representative sample.

Preleveling, wedging [less than fifty percent (50%) of width greater than minimum lift thickness], ramp pads, irregular shoulder areas, median crossovers, turnouts, and other areas where an established rolling pattern cannot be obtained shall be compacted to refusal densification.

401.03.2--Bituminous Mixing Plants.

401.03.2.1--Plant Requirements.

401.03.2.1.1--Cold Aggregate Storage. The cold storage for hydrated lime shall be a separate bulk storage bin with a vane feeder or other approved feeder system which can readily be calibrated. The system shall provide a means for easy sampling of the hydrated lime additive and verifying the quantity of lime dispensed. The feeder system shall require a totalizer.

The hydrated lime additive equipment shall be interlocked and synchronized with the cold feed controls to operate concurrently with the cold feed operation which will automatically adjust the hydrated lime feed to variations in the cold aggregate feed. A positive signal system shall be installed which will automatically shut the plant down when malfunctions cause an improper supply of hydrated lime or water.

The plant shall not operate unless the entire hydrated lime system is functioning properly.

401.03.2.1.2--Cold Aggregate Feed. The hydrated lime shall be dispensed dry or as a slurry directly onto the composite aggregate between the cold feed and the dryer. The slurry shall consist of 1 part hydrated lime to 3 parts water.

When hydrated lime is introduced dry, a spray bar or other approved system capable of spraying all aggregate with water shall be installed in order to maintain all aggregate at the moisture condition set out in Subsection 401.02.3.1 prior to addition of the hydrated lime. An alternate system for spraying the coarse aggregate stockpiles may be allowed when approved by the Engineer. The approved equipment and methods shall consistently maintain the aggregate in a uniform, surface wet condition. The moisture content of the aggregate-hydrated lime mixture, following spraying and mixing, shall be introduced into the automatic moisture controls of the plant.

The aggregate-hydrated lime mixture shall be uniformly blended by some mechanical means such as a motorized "on the belt" mixer or pug mill located between the cold feed and the dryer. Other mixing devices may be used subject to approval by the Engineer.

A maximum of forty five (45) percent of the total aggregate blend may be fed through any single cold feed bin. If the JMF calls for more than forty five (45) percent of a specific aggregate, that aggregate must be fed through two (2) or more separate cold feed bins.

401.03.2.1.3--Dryer. The efficiency of drying aggregates shall be such that the moisture content of the top HMA mixture shall not exceed 0.50 percent by weight of the total mixture, and the moisture content of all the underlying mixtures shall not exceed 0.75 percent by weight of the total mixture being produced.

401.03.2.1.4--Blank.

401.03.2.1.5--Control of Bituminous Material and Antistripping Agent. Specified bituminous materials from different manufacturers or from different refineries of a single manufacturer shall not be mixed in the plant's asphalt cement supply system storage tank and used in the work without prior written approval of the Engineer. Approval is contingent upon the Engineer's receipt of three copies of the manufacturer's certified test report(s) from the Contractor showing that the bituminous material blend conforms to the specifications.

A satisfactory method of weighing or metering shall be provided to ensure the specified quantity of bituminous material. Provisions shall be provided for checking the quantity or rate of flow. Weighing or metering devices shall be

accurate within plus or minus one-half percent.

The antistripping agent shall be injected into the bituminous material immediately prior to the mixing operation with an approved in-line injector system capable of being calibrated so as to ensure the prescribed dosage.

An in-line spigot for sampling of asphalt shall be located between the asphalt storage tank and the antistripping agent in-line injector.

401.03.2.1.6--Thermometric Equipment. An armored thermometer of adequate range and calibrated in 5°F increments shall be fixed at a suitable location in the bituminous line near the charging valve of the mixer unit.

The plant shall be equipped with an approved dial-scale, mercury-actuated thermometer, pyrometer or other approved thermometric instrument placed at the discharge chute of the dryer to measure the temperature of the material.

When the temperature control is unsatisfactory, the Engineer may require an approved temperature-recording apparatus for better regulation of the temperature.

401.03.2.1.7--Screens. A scalping screen shall be used.

401.03.2.1.8--Dust Collector. The plant shall be equipped with a dust collector constructed to waste or return collected material. When collected material is returned, it shall be returned through a controlling device which will provide a uniform flow of material into the aggregate mixture.

401.03.2.1.9--Safety Requirements. A platform or other suitable device shall be provided so the Engineer will have access to the truck bodies for sampling and mixture temperature data.

401.03.2.1.10--Blank.

401.03.2.1.11--Truck Scales. The specifications, tolerances and regulations for commercial weighing and measuring devices as recommended by the National Bureau of Standards [National Institute of Standards and Technology (NIST) Handbook 44] shall govern truck scales used in the State of Mississippi, except weighing devices with a capacity of ten thousand (10,000) pounds or more used to weigh road construction materials (i.e. sand, gravel, asphalt, fill dirt, topsoil and concrete) shall have a tolerance of one-half of one percent (1/2 of 1%) in lieu of the requirements of Handbook 44 and shall be regulated by the Mississippi Department of Transportation.

Scales shall be checked and certified by a scale company certified in heavy truck weights by the Mississippi Department of Agriculture and Commerce. In the

case of scales used for measurement of materials on Department of Transportation projects, certification shall be performed in the presence of an authorized representative of the Department or a copy of the certification may be furnished for scales that have been checked and certified within the last six months for use on other Department of Transportation projects and are still in the position where previously tested. Scales that have not been checked and certified under NIST Handbook 44 guidelines, except for the herein modified tolerances allowed, shall be so checked and certified prior to use for measurement of materials on Department of Transportation projects. Tests shall be continued on six month intervals with the test conducted in the presence of an authorized representative of the Department.

Truck scales shall be accurate to one-half of one percent of the applied load, shall be sensitive to 20 pounds, and shall have a graduation of not more than 20 pounds.

The Contractor may use an electronic weighing system approved by the Engineer in lieu of truck scales. The system shall be equipped with an automatic print out system which will print a ticket for each load with the following information:

MDOT, Contractor's name, project number, county, ticket number, load number, pay item number, item description of the material delivered, date, time of day, haul vehicle number, gross weight, tare weight, net weight and total daily net weight.

When approved by the Engineer and materials are measured directly from a storage bin equipped with load cells, exceptions may be made to the gross and tare weight requirements.

The ticket shall also have a place for recording the temperature of HMA mixtures, if applicable, and the signatures of MDOT's plant and roadway inspectors. The load numbers for each project shall begin with load number one (1) for the first load of the day and shall be numbered consecutively without a break until the last load of the day. The Contractor shall provide MDOT with an original and one copy of each ticket. When the ticket information provided by the Contractor proves to be unsatisfactory, MDOT will use imprinter(s) and imprinter tickets to record load information. All recorded weights shall be in pounds and shall be accurate to within one-half of one percent of the true weight, and the system shall be sensitive to 20 pounds. The Engineer will require random loads to be checked on certified platform scales at no cost to the Department.

When an electronic weighing system utilizes the plant scales of a batch plant, the system may be used only in conjunction with a fully automatic batching and control system.

401.03.2.2--Additional Requirements for Batching Plants.

401.03.2.2.1--Plant Scales. The plant batch scale weight shall not exceed the platform scale weight by more than one percent (1.0%).

401.03.2.3--Additional Requirements for Drum Mixing Plants.

401.03.2.3.1--Plant Controls. The plant shall be operated with all the automatic controls as designed and provided by the plant manufacturer. If the automatic controls malfunction, brief periods of manual operations to complete the day's work or to protect the work already placed may be conducted with the approval of the Engineer. During manual operation, the Contractor must continue to produce a uniform mixture meeting all contract requirements.

401.03.2.3.2--Aggregate Handling and Proportioning. A screening unit shall be placed between the bins and the mixer to remove oversized aggregate, roots, clayballs, etc.

401.03.2.4--Surge or Storage Bins. Surge and/or storage systems may be used at the option of the Contractor provided each system is approved by the Department prior to use. Surge bins shall be emptied at the end of each day's operation. Storage silos may be used to store mixtures as follows:

19 mm & 25 mm mixtures	24 hours
9.5 mm & 12.5 mm mixtures	36 hours

The storage silos must be well sealed, completely heated and very well insulated. The mixture when removed from the storage silo shall be tested to ensure that it meets all the same specifications and requirements as the mixture delivered directly to the paving site. See Subsection 401.02.5.3, subparagraph (i) for sampling and testing requirements.

401.03.3--Hauling Equipment. The inside surfaces of each vehicle bed shall be coated with a light application of water and thin oil, soap solution, lime water solution or other approved material to prevent the mixture from sticking. Diesel fuel or gasoline shall not be used to lubricate vehicle beds. Truck beds shall be raised to drain excessive lubricants before placing mixture in the bed. An excess of lubricant will not be permitted.

401.03.4--Bituminous Pavers. The screed or strikeoff assembly shall be capable of vibrating and heating the full width of the mixture being placed and shall lay the lift with an automatic control device to the specified slope and grade without tearing, pulling or gouging the mixture surface.

401.03.5--Rollers. All rollers shall be self-propelled units capable of maintaining a smooth and uniform forward and reverse speed as required for

proper compaction. They shall be equipped with adjustable scrapers, water tanks, mats and a device for wetting the wheels or tires to prevent the mixture from sticking. Adhesion of the mixture to the rollers will not be permitted. The use of diesel fuel or gasoline for cleaning roller wheels or tires or to aid in preventing the mixture from sticking to the wheels or tires is prohibited.

All rollers shall be in good mechanical condition, free from leaking fuels and lubricants, loose link motion, faulty steering mechanism, worn king bolts and bearings. They shall be operational at slow speeds to avoid displacement of the mixture and capable of reversing direction smoothly and without backlash.

401.03.6--Preparation of Grade. The foundation upon which HMA pavement is to be placed shall be prepared in accordance with the applicable Section of the Standard Specification.

Unless otherwise directed, tack coat shall be applied to the underlying surface on which the mixture is to be placed. Emulsions, if used, must be allowed to "break" prior to placement of the bituminous mixture.

Bituminous mixture shall not be placed against the edge of pavements, curbs, gutters, manholes and other structures until sprayed with a thin uniform tack coating. The tack coat shall be protected until the mixture has been placed.

Existing HMA pavements that require preliminary leveling or patching in advance of placing the bituminous mixture shall be sprayed with a tack coat material and then brought as nearly as practicable to uniform grade and cross section. The material shall be placed by hand or machine in one or more compacted layers approximately two (2) inches or less in compacted thickness.

401.03.7--Blank.

401.03.8--Preparation of Mixture. The temperature of the mixture, when discharged from the mixer, shall not exceed 340°F.

401.03.9--Material Transfer Equipment. Except for the areas mentioned below, when placing the top intermediate lift and/or the top lift of HMA pavements, the material transferred from the hauling unit shall be remixed prior to being placed in the paver hopper or insert by using an approved Materials Transfer Device. Information on approved devices can be obtained from the State Construction Engineer. Areas excluded from this requirement include: temporary work of short duration, detours, bridge replacement projects having less than 1,000 feet of pavement on each side of the structure, acceleration and deceleration lanes less than 1,000 feet in length, tapered sections, transition sections for width, shoulders less than 10 feet in width, crossovers, ramps, side street returns and other areas designated by the Engineer.

401.03.10--Spreading and Finishing. Grade control for HMA pavements shall be established by stringline at least 500 feet ahead of spreading, unless placement is adjacent to curb and gutter, concrete pavement, or other allowed grade control. The mixture shall be spread to the depth and width that will provide the specified compacted thickness, line, grade and cross section. Placing of the mixture shall be as continuous as possible. On areas where mechanical spreading and finishing is impracticable, the mixture may be spread, raked and luted by hand tools.

Immediately after screeding and prior to compaction, the surface shall be checked by the Contractor and irregularities adjusted. When the edge is feathered as in a wedge lift, it may be sealed by rolling. Irregularities in alignment and grade along the edges shall be corrected before the edges are rolled.

Hauling, spreading and finishing equipment shall be furnished that is capable of and operated in such a manner that the rolling operation will satisfactorily correct any surface blemishes.

The longitudinal joint in the subsequent lift shall offset that in the underlying lift by approximately six (6) inches. However, the joint in the top lift shall be at the centerline or lane line.

401.03.11--Compaction. After the mixture has been spread and surface irregularities corrected, it shall be thoroughly and uniformly compacted to the required line, grade, cross section and density.

401.03.12--Joints. Joints between previously placed pavement and pavement being placed shall be so formed as to insure thorough and continuous bond.

Transverse construction joints shall be formed by cutting the previously placed mixture to expose the full depth of the lift.

The contact surface of transverse joints and longitudinal joints, except hot joints, shall be sprayed with a thin uniform tack coating before additional mixture is placed against the previously placed material.

Longitudinal joints shall be formed by overlapping the screed on the previously placed material for a width of at least one (1) inch and depositing the quantity of mixture to form a smooth, tight joint.

401.03.13--Pavement Samples. The Contractor shall cut samples from each lift of HMA at the time and locations designated by the Engineer. The samples shall be taken for the full depth of each lift and shall be of a size approved by the Engineer but not to exceed 120 square inches. Tools used for cutting or coring of samples shall be of the revolving blade type such as saw or core drill. Cores shall be taken using a 4.0 to 6.0-inch inside diameter coring bit. The sample hole

shall be filled, compacted and finished by the Contractor to conform with the surrounding area. No additional compensation will be allowed for furnishing samples and repairing the areas with new pavement.

SECTION 403 - HOT MIX ASPHALT PAVEMENT

403.01--Description. This work consists of constructing one or more lifts of HMA pavement meeting the requirements of Section 401 on a prepared surface in accordance with the requirements of this section and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer. This work shall also include applicable in-grade preparation of the underlying course in accordance with Section 321.

403.02--Material Requirements. Materials and their use shall conform to the applicable requirements of Subsection 401.02.

403.03--Construction Requirements.

403.03.1--General. Construction requirements shall be as specified in Subsection 401.03 except as otherwise indicated in this section or applicable special provisions.

403.03.2--Smoothness Tolerances. Except as noted herein, the finished smoothness of each lift shall conform to the designated grade and cross section within the following tolerances from grade stakes or other grade reference points set at 25 foot intervals:

	Lower* & Leveling Lifts	Lower* Intermediate Lift	Top Intermediate Lift	Surface Lift
Maximum deviation from grade and cross section at any point	1/2"	3/8"	1/4"	1/4"
Maximum deviation from A 10 foot straight edge.....	3/8"	1/4"	1/8"	1/8"
Profile Index (PI) inches/mile	-	-	45.0	30.0

Note: Where more than four (4) lifts of HMA are required, all lifts, excluding the top three (3) lifts, shall meet the requirements of the lower lift.

- * When tested longitudinally from a stringline located equidistant above points 50 feet apart, the distance from the stringline to the surface at any two points located 12 1/2 feet apart shall not vary one from the other more than the maximum deviation allowed above from a 10-foot straight edge.

Where only one intermediate lift is required, it shall meet the smoothness requirements for lower intermediate lifts and shall have a Profile Index of not more than 60.0 inches per mile. The surface lift shall have a Profile Index of not more than 30.0 inches per mile.

Where only a leveling lift and a surface lift are required, the surface lift shall meet the smoothness requirements for lower intermediate lifts, and shall have a Profile Index of not more than 60.0 inches per mile.

Where only a surface lift is required, the Contractor shall determine the existing surface profile index at no additional cost to the State. The finished surface lift shall have a profile index of sixty percent (60%) of the profile index of the existing surface or 60.0 inches per mile, whichever is greater.

Where milling is required to remove undesirable material and/or correction of the cross-slope and only one (1) lift is required, the lift shall have a Profile Index of not more than 45.0 inches per mile.

Where milling is required to remove undesirable material and/or correction of the cross-slope and a leveling lift and a surface lift are required, the surface lift shall have a Profile Index of not more than 45.0 inches per mile.

Where milling is required to remove undesirable material and/or correction of the cross-slope and two (2) lifts are required, the lower lift shall have a Profile Index of not more than 45.0 inches per mile and the surface lift shall have a Profile Index of not more than 30.0 inches per mile.

Grade stakes or other grade reference points set at 25-foot intervals and maximum deviation from grade and cross section will not be required provided an approved profile averaging device is furnished and properly used for the four conditions set forth herein; however, all other surface requirements are applicable.

- (a) Overlays with one overall lift.
- (b) Overlays with two or more overall lifts -- for each lift above the first overall lift provided each underlying overall lift is within the allowable tolerances.
- (c) Surface lift of new construction provided the underlying lift is within the

allowable tolerances.

- (d) Full-depth asphalt construction for lifts above the lower lift provided the lower lift is within the specified tolerances for the lower intermediate lift.

In the placement of full depth HMA pavement, where the chemically treated base is constructed, graded and/or trimmed, full lane width, to a surface tolerance of $\pm 3/8$ inches from design grade, stringline grade controls may be eliminated for the placement of the asphalt drainage course and all HMA lifts. In addition, where the base course is crushed stone or crushed concrete and is constructed to a surface tolerance of $\pm 3/8$ inches from design grade using a stringline controlled spreader, stringline grade controls may be eliminated for the placement of the asphalt drainage course and all HMA lifts.

All other tolerances as specified in Section 321 are applicable, except for bases, when tested longitudinally, the maximum deviation when measured at the 12½-foot midpoint shall be $\pm 3/8$ inches.

Acceptance and payment of HMA will be determined on a lot to lot basis by cores taken from the completed pavement as outlined in Subsection 403.03.3.

Approved contacting type profile averaging devices are those devices capable of working in conjunction with a taut string or wire set to grade, or ski-type device with extreme contact points with the surface at least 30 feet apart. Approved non-contacting type profile averaging devices are laser type ski devices with at least four referencing mobile stations at a minimum length of 24 feet, or an approved equal.

When approved by the Engineer, a short ski or shoe may be substituted for a long ski on the second paving operation working in tandem.

During the finishing and compacting of pavement lifts, it shall be the responsibility of the Contractor to check the surface and joints for progress toward conformance to surface requirements set forth herein. Variations from surface requirements exceeding the allowable tolerances shall be corrected at the Contractor's expense.

When a portland cement concrete pavement is to be placed on a HMA lift, the finished top of the HMA lift shall meet the requirements of Sections 321 and 501.

When the Profile Index for the final surface lift is less than or equal to twenty-two inches per mile (22.0 inches / mile), per segment, a unit price increase will be added. The following schedule lists the Profile Index range and the corresponding contract price adjustment:

Profile Index inches / mile / segment	Contract Price Adjustment percent of HMA unit bid price
less than 10.0	108
10.0 to 14.0	106
14.1 to 18.0	104
18.1 to 22.0	102
22.1 to 30.0	100
over 30.0	100 with correction of $PI \leq 30.0$

Contract price adjustments for rideability shall only be applicable to the surface lift and furthermore to only the segment(s) or portions of the segments(s) of the surface lift that require smoothness be determined by using a profilograph and then only when the surface tolerance requirements include a profile index of 30.0 inches / mile.

Segment(s) or portions thereof representing areas excluded from a smoothness test with the profilograph shall also be excluded from consideration for a contract price adjustment for rideability.

Any contract price adjustment for rideability will be applied on a segment to segment basis to the pay tonnage, determined in accordance with Subsections 401.02.6.5 and 403.04, for the segment(s) or portions thereof for which an adjustment is warranted.

403.03.3--Thickness Requirements. Hot mix asphalt overlay lifts shall be constructed as nearly in accordance with the thickness shown on the plans as the underlying pavement and foundation will permit. Periodic and cumulative yield tests will be made to determine practicable conformity to the thickness of each lift. The Engineer may order modifications in placement thicknesses to prevent unwarranted variations in plan quantities.

When the paver is operating off an established grade line, no thickness determination will be required for the various lifts of pavement. It is understood that the tolerances from design grade will control the thickness requirements.

When grade stakes are eliminated by Notice to Bidders or as outlined in Subsection 403.03.2(d) and where resulting in the placement of two (2) or more lifts, acceptance and payment will be determined on a lot to lot basis by cores taken from the completed pavement. Lots will be coincidental with acceptance lots for the surface lift as provided in Subsection 401.02.6.4, except that only lots resulting from the placement of mainline surface lift will be used for thickness assessment. One core will be obtained at random from each lot. Irregular areas will not be cored.

When the average thickness of all the cores from the lots representing a day's production, excluding any discarded by the Engineer for justifiable reason, is within $3/8$ of an inch of the total pavement thickness shown on the plans, excluding lift(s) placed using an established grade line, corrective action will not be required and a price adjustment will not be made for non-conformity to specified thickness.

When the average thickness of all the cores from the lots representing a day's production is deficient in thickness by more than three-eighths of an inch ($3/8''$) of the total pavement thickness shown on the plans, excluding lift(s) placed using an established grade line, the deficiency shall be corrected by overlaying the entire length of the day's production. The thickness of the overlay shall be equal to the thickness deficiency but no less than the minimum single lift laying thickness for the specified mixture.

When the thickness of all the cores from the lots representing a day's production is more than three-eighths of an inch ($3/8''$) thicker than the total thickness shown on the plans, excluding lift(s) placed using an established grade line, a price adjustment will be made in accordance with Subsection 403.05.1.

The cores shall be cut and removed by the Contractor in the presence of the Engineer's representative and turned over to the Engineer's representative for further handling. The Contractor shall fill each core hole with surface lift mixture and compact to the satisfaction of the Engineer within 24 hours after coring.

403.03.4--Lift Corrections. Pavement exceeding the allowable surface tolerances shall be corrected at the Contractor's expense by the following methods:

Lower, Leveling and Lower Intermediate Lifts:

- (a) Removal or addition of mixture by skin patching, feather edging, wedge lift construction or full depth patching where appropriate and can be completed in a satisfactory manner.
- (b) Superimposing an additional layer which shall be an approved grade raise for the full roadway width and length of the area to be corrected.

Top Intermediate Lift:

- (a) Removal and the addition of sufficient mixture to provide the specified thickness. Corrections by this method shall be square or rectangular in shape and shall completely cover the area to be corrected.
- (b) Superimposing an additional layer of minimum lift thickness for mixture

being used which shall be an approved grade raise for full roadway width of the area to be corrected. Transverse joints shall be perpendicular to the centerline of the pavement.

Surface Lift:

- (a) Removal and the addition of sufficient mixture to provide new material of at least minimum single lift laying thickness for full lane width of the area to be corrected. Transverse joints shall be perpendicular to the centerline of the lane.
- (b) Superimposing an additional layer (minimum lift thickness for mixture being used) which shall be an approved grade raise for full roadway width of the area to be corrected. Transverse joints shall be perpendicular to the centerline of the pavement.

All mixtures used in the correction of unacceptable pavement shall be approved by the Engineer prior to use.

403.03.5--Overlays or Widening and Overlays. In addition to the requirements of Subsections 403.03.1 through 403.03.4, the following requirements will be applicable when an existing pavement is to be overlaid or widened and overlaid.

403.03.5.1--Blank.

403.03.5.2--Sequence of Operations. In order to expedite the safe movement of traffic and to protect each phase of the work as it is performed, a firm sequence of operations is essential. Unless otherwise provided in the traffic control plan and/or the contract, the following appropriate items of work shall be begun and continually prosecuted in the order listed:

- (a) In sections designated by the Engineer, trim the shoulders along the pavement edges to provide drainage from the pavement.
- (b) Perform prerolling to locate areas of pavement with excessive movement per Section 511.
- (c) Perform selective undercutting and patching as directed per Subsection 403.03.5.4.
- (d) Perform pressure grouting as specified in Section 512.
- (e) Clean and seal joints per Section 413.
- (f) Complete preparation on one side of roadway to be widened and place widening materials.

- (g) Reconstruct shoulders to elevation necessary to assure traffic safety.
- (h) Open the widened section to traffic.
- (i) Complete above work for other side of roadway.
- (j) Perform preliminary leveling as directed.
- (k) Apply interlayer as specified.
- (l) Place the first overall leveling lift.
- (m) After the first overall leveling lift, reconstruct shoulders as necessary to eliminate vertical differentials which may be hazardous to traffic.
- (n) Place first intermediate lift.
- (o) Construct shoulders to the contiguous elevation of the first intermediate lift.
- (p) Place remaining intermediate lift, if required.
- (q) Place surface lift.
- (r) Complete construction of shoulders.
- (s) Apply permanent traffic marking.
- (t) Final cleanup.

The above operations shall be performed in such a manner that traffic will be maintained on a paved surface at all times. Two-lane, two-way highways should not be restricted to a single lane in excess of a 3,000 foot section.

403.03.5.3--Widening of Pavement. The foundation for widening shall be formed by trenching or excavating to the required depth and constructing a smooth, firm and compacted foundation. It shall have sufficient density and stability to withstand the placement and compaction of subsequent lifts. Soft, yielding and other unsuitable material which the Engineer determines will not compact readily shall be removed and backfilled with granular material or hot mix asphalt as directed.

Except as provided herein, excavation for widening, undercutting or other required excavation shall be spread along the edge of the shoulders, foreslopes or other adjacent areas as directed and will be an absorbed item. When the quantity is in excess of what may be used satisfactorily on adjacent areas, the Engineer

may direct that the material be loaded, hauled and spread uniformly on other designated areas. In this case, compensation for handling surplus material will be in accordance with the appropriate pay items as provided in the contract or as extra work.

If the plans require widening of the shoulders or embankment with Contractor furnished material, all suitable material obtained from widening excavation may be used and will be measured and paid for as Contractor furnished materials. No measurement for payment of haul will be made.

Removal and disposal of old stakes, forms and other debris encountered in excavating shall be in accordance with Section 201 and shall be considered as incidental to and included in the unit prices bid for other items. No separate measurement will be made therefor. Pavement edges and surfaces shall be cleaned prior to final shaping and compaction of adjacent trenching or undercut areas.

Granular material for widening shall be placed on a previously prepared, smooth, firm and unyielding foundation in accordance with the typical section. Density of the granular material shall be as specified.

Hot mix asphalt for widening, including trench widening, shall meet the applicable requirements of this section and Section 401 and shall be placed in one or more layers as shown on the plans or directed. The surface of the mixture shall be finished as a continuation of the adjacent pavement slope.

Trench rollers or other compaction equipment shall be used to compact the foundation, granular material and bituminous mixtures for widening when standard width rolling equipment cannot be used.

403.03.5.4--Patching. Existing pavement which has failed or unsatisfactorily stabilized shall be removed as directed. Removal of pavement will be measured and paid for under the appropriate pay items as provided in the contract.

Backfill shall consist of hot mix asphalt or a combination of compacted layers of granular material and hot mix asphalt. Unless otherwise specified, the Engineer will make this determination based on depth and field conditions.

Hot mix asphalt used for backfilling will be measured and paid for at the contract unit price for the mixture designated on the plans as the lowest lift. Granular material will be measured and paid for under the appropriate pay item as provided in the contract or as extra work.

403.03.5.5--Preliminary Leveling. All irregularities of the existing pavement that result in a thickness greater than approximately two and one-half inches for the first overall leveling lift shall be corrected by skin patching, feather edging or

a wedge lift and shall be approved by the Engineer in advance of placing the first overall lift.

403.03.5.6--Placement of Lifts. The leveling lift shall be placed in a layer, or layers, not exceeding approximately two and one-half inches compacted thickness.

When single lane construction is required, placement of a lift on the adjacent lane may be performed by an approved profile averaging device provided the lane previously placed is within the allowable tolerances for all surface requirements. When any of the tolerances are exceeded, the Contractor shall reestablish the control stringline for laying the adjacent lane should the Contractor elect to perform this work prior to correcting the deficiencies of the lane previously placed. In no case shall a "matching shoe" be used to control the grade of an adjacent lane.

In instances where there are only minor deviations from the allowable tolerances in the first overall lift, the Engineer may permit the Contractor to place the next higher lift by graded stringline in lieu of making the corrections.

Single lane placement of leveling, intermediate and surface lifts shall be limited to the distance covered in one and one-half days in advance of that placed in the adjacent lane.

403.03.5.7--Protection of Pavement. The pavement shall be protected and properly maintained until it has been compacted and cooled sufficiently for use by traffic.

403.04--Method of Measurement. HMA pavement, complete in place and accepted, will be measured by the ton. The weight of the composite mixture shall be determined in accordance with the provisions of Subsection 401.03.2.1.11.

Unless shown as a separate pay item, the furnishing and application of the tack coat will not be measured for payment. When payment is provided, tack coat will be measured as set out in Subsection 407.04.

The quantity of bituminous mixture required to correct the work, when made at the expense of the Contractor, will not be measured for payment.

Any trenching required for widening will not be measured for payment, such cost thereof shall be included in other items of work.

Undercut required by the Engineer will be measured for payment under the appropriate excavation item as provided in the contract or as extra work. Pavement removal and any required trenching will not be included in the

measurement for undercut.

Class "B" structural concrete base substituted for hot mix asphalt under portland cement concrete bridge end pavement, as per Subsection 502.03.1, will be paid for as hot mix asphalt calculated as follows:

Square yards of portland cement concrete bridge end pavement x concrete base thickness in inches x 0.055 = tons of hot mix asphalt.

403.05--Basis of Payment. Subject to the adjustments set out in Subsections 401.02.6.3, 401.02.6.4, 401.02.6.5 & 403.03.2, hot mix asphalt pavement, complete-in-place, accepted, and measured as prescribed above, will be paid for at the contract unit price per ton for each lift of pavement specified in the bid schedule and shall be full compensation for completing the work.

403.05.1--Price Adjustment for Thickness Requirement. When grade stakes are eliminated as provided in Subsection 403.03.3 and the average thickness of all cores from lots representing a day’s production is more than 3/8 inch thicker than the total specified thickness of the pavement, excluding lift(s) placed using an established grade line, a lump sum reduction in payment for the surface lift of lots representing a day’s production will be made as follows:

Individual Day’s L.S. Reduction = (Monetary Value of the Day’s Surface Lift Production) x $\frac{(D - 3/8)}{ST}$

Where:

D = The day’s average deviation from total pavement thickness shown on the plans, excluding lift(s) placed using an established grade line.

ST = Specified thickness for surface lift.

The total L.S. reduction for the project is the summation of the individual day’s reductions in payment.

403.05.2--Pay Items.

Payment will be made under:

403-A: Hot Mix Asphalt, $\frac{(1)}{\text{Type}}, \frac{(2)}{\text{Mixture}}$ - per ton

403-B: Hot Mix Asphalt, $\frac{(1)}{\text{Type}}, \frac{(3)}{\text{Mixture}}$, Leveling - per ton

403-C: Hot Mix Asphalt, (1), (4), Trench Widening - per ton
Type Mixture

403-D: Hot Mix Asphalt, HT, (3), Polymer Modified - per ton
Mixture

403-E: Hot Mix Asphalt, HT, (3), Polymer Modified, Leveling - per ton
Mixture

- (1) ST, MT or HT
- (2) 4.75 mm mixture, 9.5 mm mixture, 12.5 mm mixture, 19 mm mixture or 25 mm mixture
- (3) 4.75 mm mixture, 9.5 mm mixture, 12.5 mm mixture or 19 mm mixture
- (4) 19 mm mixture or 25 mm mixture

SECTION 404 - COLD BITUMINOUS PAVEMENT

404.01--Description. This work consists of constructing one or more courses of cold bituminous pavement in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer. This work shall also include applicable in-grade preparation of the underlying course in accordance with Section 321.

The bituminous pavement shall be composed of aggregates and bituminous material, and, if specified, a top dressing of sand, gravel, stone, or slag screenings.

404.02--Materials.

404.02.1--General. Cold bituminous mixtures shall be either a preapproved commercial cold mix as listed on the Department's Approved Products List, or conform to the requirements of the Department's standard cold mixture as set out below.

404.02.2--Preapproved Commercial Cold Bituminous Mixture. Commercial cold bituminous mixture must be an approved product as listed on the Department's List of Approved Products and Suppliers. Such approval will be based on satisfactory performance of the cold bituminous mixture on a field test section, placed in accordance with the manufacture's recommendations, after from six months to one year's evaluation by the Department. The mixture shall have a minimum shelf life of six months.

404.02.3--MDOT Standard Cold Bituminous Mixtures - General. MDOT standard cold bituminous mixtures shall conform to the requirements of

Subsection 703.13 and the requirements as set out below. The mixture shall have a minimum shelf life of six months.

404.02.3.1--Mineral Filler. Mineral filler shall meet the requirements of Subsection 703.16. Mineral filler may be used as necessary to obtain desired properties of the mixture; however, excessive use will not be permitted.

404.02.3.2--Bituminous Materials. Bituminous material shall be cutback asphalt of one of the grades set out in AASHTO Designation: M 82 or, in lieu thereof, a combination of petroleum asphalt cement Grade PG 58-28, 64-22 or 67-22 conforming to Section 702 and a liquefier.

404.02.3.3--Hydrated Lime. Hydrated lime meeting the requirements of Subsection 714.03.2 may be used as a facilitator in the mixture and will be required when siliceous aggregates are used.

404.03--Construction Requirements.

404.03.1--General. Construction requirements shall be as prescribed in Subsection 401.03, except as modified in the following subsections.

404.03.2--Weather Limitations. Cold bituminous pavement courses shall be placed only when the air temperature is 40°F or above.

404.03.3--Tack Coat. Unless otherwise directed by the Engineer, tack coat shall be applied at a minimum rate of 0.05 gallon per square yard residual asphalt. The tack coat shall be applied as a complete coating, fog coating, or "spider webbing" as directed.

404.03.4--Preparation of Aggregate. When combined with cut-back asphalt, aggregates shall be dry and at a temperature of at least 60°F and not more than 225°F. If not already surface dry, aggregates shall be dried at a temperature between 150°F to 300°F and then cooled before being mixed with bituminous material.

When combined with emulsified asphalt, the aggregates shall be at a temperature of at least 60°F and not more than 175°F.

404.03.5--Mixing. The prepared aggregates shall be combined in the quantities required to meet the job-mix formula, introduced into the mixer, and mixed dry for a period sufficient to distribute the various sizes uniformly throughout the batch. The bituminous material shall then be introduced and mixed until the aggregates are thoroughly coated and the mass is a uniform color.

The mixing time for each phase of the mixing operations will be set by the Engineer, based on the nature of the aggregates, the job-mix formula, and the size

of the batch, but in no case shall the mixing time, after introduction of the bituminous material, be less than two minutes.

404.03.6--Spreading and Finishing. The material shall be spread by a motor grader or mechanical paver.

Where the compacted thickness is to be more than two inches, the mixture shall be spread and compacted in layers of no more than two inches in thickness. When spreading with a motor grader the mixture shall be dumped along the centerline or along the outside quarter point in sufficient volume to produce the weight per square yard indicated or directed. It shall then be moved for its full depth and formed into a windrow of uniform section. The windrow shall then be spread, at the prescribed rate per square yard.

While the surface is being compacted and finished, the edges shall be shaped to a neat line.

404.03.7--Compaction. Immediately after the mixture has been spread, it shall be thoroughly and uniformly compacted. Rolling shall extend over a period of three days after the initial rolling and shall consist of a minimum of two coverages each day.

404.03.8--Top Dressing. When a top dressing of aggregate is specified, it shall be applied immediately after the rolling of the surface course. The top dressing shall be applied at the rate specified and rolled as directed.

404.03.9--Surface Tolerances. The distance at any point from a 10 foot straight edge to the surface shall not exceed three- sixteenths inch. Lumps or depressions exceeding this tolerance shall be corrected by removing defective work and replacing with new material as directed.

404.04--Method of Measurement. Cold bituminous pavement of the type specified will be measured by the square yard or ton. When measured by the ton, measurement will be as prescribed in Subsection 401.04.

404.05--Basis of Payment. Cold bituminous pavement will be paid for by the square yard or ton. Payment on a tonnage basis, will be as set out in Subsection 401.05, except no reduction in payment will be made for compaction.

Payment will be made under:

404-A: ____” Cold Bituminous Pavement, Type _____ - per square yard or ton

404-B: Aggregate Top Dressing _____ - per ton

SECTION 406 - COLD MILLING

406.01--Description. This work consists of removal of pavement materials on the roadway and shoulders by cold milling to the designated depth and, loading, hauling, and disposal of the milled materials by the Contractor in accordance with the plans and specifications, or as directed by the Engineer. The milled surface shall provide a desirable surface free from gouges, continuous grooves, ridges, oil film, and other imperfections of workmanship and shall have a uniform appearance.

406.02--Blank.

406.03--Construction Requirements.

406.03.1--Equipment. The equipment to be used for this work shall be a self-propelled milling machine capable of removing a minimum width of four feet. The equipment shall have sufficient power, traction, and stability to remove material and maintain an accurate grade and cross slope. The equipment shall be capable of accurately and automatically establishing profile grades along each edge of the machine by referencing from the existing pavement with means of an approved profile averaging device with extreme contact points with surface at least 30 feet apart, or from an independent grade line and shall have an automatic system for controlling cross slope. The machine shall be equipped with an integral loading and reclaiming means to immediately remove material being cut from the surface and discharge the cuttings into a truck or windrow, all in one operation.

Adequate back-up equipment, such as mechanical sweepers, loaders, water truck, etc., and personnel shall be provided to insure that all cuttings are removed immediately behind the milling machine.

406.03.2--Construction Methods. On the roadway, when hot mix asphalt will be required on the milled area, milling operations shall not begin until the Contractor has an approved job-mix formula and is prepared to begin paving operations. The milled roadway area opened to public traffic shall be covered by placing the first required course within 30 calendar days after milling. During the period from November 1 to March 1, the uncovered milled area shall not exceed one mile of full roadway width.

The pavement and shoulder materials shall be removed to the depth, width, grade, and cross section shown on the plans, or as directed by the Engineer. The number of passes necessary to accomplish the work required herein and on the plans shall be determined by the Contractor.

The surface of the pavement and shoulders, after milling, shall be reasonably smooth and true to the established line, grade and cross section. Areas damaged by the Contractor's operations shall be corrected and/or repaired as directed by

the Engineer at no additional costs to the State. The Contractor shall take necessary action to prevent or minimize the ponding of water on the milled roadway and shoulder.

Where traffic is required to be maintained adjacent to the milled area, no more than a 2¼-inch differential in grade between the milled area and the adjacent surface will be allowed, unless a positive separation in accordance with the plans and specifications is established between the traffic and milled area.

A longitudinal pavement edge that traffic is expected to move across should have an elevation difference of not more than 2¼ inches. If the pavement edge is more than 1½ inches and less than or equal to 2¼ inches, uneven pavement signs will be required as shown in the plans, or contract documents. If the pavement edge is less than or equal to 1½ inches, no uneven pavement signs will be required. Transverse pavement joints shall be sufficiently tapered to allow for the safe movement of traffic.

When traffic is required to be maintained adjacent to milled shoulders, traffic control devices shall be placed in accordance with the requirements of the detail sheet for shoulder closures, or as directed by the Engineer.

It is understood that the milled shoulder shall be covered with the next required course as soon as possible but in no case later than 30 calendar days after milling.

406.04--Method of Measurement. Cold milling of pavement, all depths, will be measured by the square yard, cubic yard (LVM), or ton as indicated in the contract. Loading, hauling, and disposal will not be measured for separate payment.

406.05--Basis of Payment. Cold milling of pavement, all depths, measured as prescribed above, will be paid for at the contract unit price per square yard, cubic yard (LVM) or ton, as indicated, which price shall be full compensation for completing the work.

When not shown as a separate pay item in the contract, the price for each item of cold milling shall include the cost of continuous maintenance of traffic and protective services as required by the Department's Traffic Control Plan, including all required individual traffic control devices.

Payment will be made under:

406-A: Cold Milling of Bituminous Pavement, All Depths	- per square yard, cubic yard or ton
406-B: Cold Milling of Concrete Pavement, All Depths	- per square yard, cubic yard or ton

SECTION 407 - TACK COAT

407.01--Description. This work consists of preparing and treating an existing bituminous or concrete surface with bituminous material in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.

407.02--Materials.

407.02.1--Bituminous Material. The materials shall conform to the applicable requirements of Section 702. The particular type and grade will be specified in the contract or by the Engineer.

When emulsified asphalt is used, it shall not be diluted without approval of the Engineer.

407.03--Construction Requirements.

407.03.1--Equipment. The Contractor shall provide equipment for heating and applying bituminous material. Heating equipment and distributors shall meet the requirements of Subsection 410.03.3. Other equipment for applying tack coat shall be approved by the Engineer prior to use.

407.03.2--Preparation of Surface. The existing surface shall be prepared in accordance with Subsections 401.03.6 and 410.03.4.

407.03.3--Application of Bituminous Material. The tack coat shall be applied in such a manner as to offer the least inconvenience to traffic and to permit one-way traffic without pickup or tracking of the bituminous material. Tack coat shall not be applied during wet or cold weather, after sunset, or to a wet surface. The quantity, rate of application, temperature, and areas to be treated shall be approved prior to application. Emulsions shall be allowed to "break" prior to superimposed construction.

407.04--Method of Measurement. Unless shown as a separate pay item in the proposal, tack coat will not be measured for direct payment, but shall be considered a necessary part of the construction involved, and the cost thereof shall be included in the appropriate contract unit prices.

When shown as a separate pay item, bituminous tack coat material will be measured by the gallon as prescribed in Subsections 109.01 and 410.04.

Emulsified asphalt as delivered by the producer will be measured prior to any dilution that may be required by the Engineer.

407.05--Basis of Payment. When shown as a separate pay item in the contract,

tack coat will be paid for at the contract unit price per gallon, which price shall be full compensation for completing the work.

Payment will be made under:

407-A: Asphalt for Tack Coat, Grade - per gallon

SECTION 408 - PRIME COAT

408.01--Description. This work consists of preparing and treating an existing surface with bituminous material, and blotter material if required, in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.

408.02--Materials.

408.02.1--Bituminous Materials. The bituminous material shall conform to the applicable requirements of Section 702. The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer at no change in unit price.

408.02.2--Blotter Material. Blotter material shall be sand clay or other friable or near friable material approved by the Engineer.

408.03--Construction Requirements.

408.03.1--Seasonal and Weather Limitations. Bituminous material shall be applied only when permitted under the seasonal and weather limitations specified in Subsection 410.03.2.

408.03.2--Equipment. The Contractor shall provide equipment for heating and applying bituminous material. Heating equipment and distributors shall meet the requirements of Subsection 410.03.3.

408.03.3--Preparation of Surface. The surface to be primed shall be prepared in accordance with Section 321 free from ruts, corrugations, segregated material, or other irregularities. It shall be conditioned as set out in Subsection 410.03.4.

408.03.4--Application of Bituminous Material. The bituminous material shall be applied in accordance with applicable requirements of Subsection 410.03.5.

408.03.5--Application of Blotter Material. The Contractor shall furnish and spread, at no additional cost to the State, the minimum necessary quantity of approved blotter material over the prime coat where necessary under the requirements of Subsection 104.04.

408.03.6--Maintenance. The Contractor shall maintain the prime coat in a satisfactory condition until covered by subsequent construction. Maintenance shall include immediate repairs of all damage that may occur. All maintenance shall be performed at the expense of the Contractor, and shall be repeated as often as necessary to properly maintain the work.

408.04--Method of Measurement. Asphalt for prime coat will be measured by the gallon as prescribed in Subsections 109.01 and 410.04. Blotter material will not be paid for separately but shall be included in the unit price per gallon for prime coat.

408.05--Basis of Payment. Asphalt for prime coat, measured as prescribed above, will be paid for at the contract unit price per gallon., which prices shall be full compensation for all incidentals necessary to complete the work.

Payment will be made under:

408-A: Asphalt for Prime Coat, Grade - per gallon

SECTION 409 - GEOTEXTILE FABRIC FOR UNDERSEAL

409.01--Description. This work consists of furnishing and placing fabric underseal in accordance with the details shown on the plans and the requirements of these specifications. An underseal shall consist of an application of asphalt cement covered with a layer of fabric.

409.02--Materials.

409.02.1--Geotextile Fabric. The fabric shall meet the specific requirements for geotextile fabric underseal contained in Subsection 714.13.4 and the applicable requirements of Subsection 714.13.

409.02.2--Bituminous Material. Unless otherwise designated, the asphalt sealant shall be asphalt cement Grade PG 64-22 meeting the applicable requirements of Section 702.

409.03--Construction Requirements.

409.03.1--Equipment. The Contractor shall provide equipment for heating and applying bituminous material and for laying the pavement fabric.

Heating equipment and distributors shall meet the requirements of Subsection 410.03.3.

The mechanical fabric laydown equipment shall be capable of handling full rolls

of fabric and shall be capable of laying the fabric smoothly without excessive wrinkles and/or folds. When manual laydown is required, a length of standard one inch pipe and suitable roll tension devices shall be used for proper roll handling.

The fabric manufacturer or distributor shall furnish a technician to supervise installation of the fabric and training of Contractor's personnel.

409.03.2--Surface Preparation. The surface to be treated, and at least one additional foot on each side, shall be cleaned by sweeping, blowing, or other methods until all dust, dirt, mud, vegetation, and foreign materials are removed entirely from the pavement before the asphalt sealant is applied. Care shall be exercised to prevent material so removed from becoming mixed with subsequent courses.

409.03.3--Application of the Asphalt Sealant. The application of the asphalt sealant shall conform to the applicable requirements of Section 410. The sealant shall be uniformly sprayed over the area to be covered by fabric at a rate recommended by the fabric manufacturer or distributor's technician and/or ordered by the Engineer. The rate of application is usually between 0.20 and 0.40 gallon per square yard. Varying surface conditions such as the degree of porosity of the existing pavement will cause varying application rates. The quantity applied shall be sufficient to bond and saturate the fabric, and to bond the subsequent overlay course to the fabric. Within intersections or other zones where vehicle braking is frequent, the application rate should be reduced. The sealant shall be applied to an area two to six inches wider than the width of fabric being placed, but restricted to the area of immediate fabric laydown. Application shall be by distributor spray bar with hand hose spraying allowed only where the distributor spray bar cannot be used. Asphalt leakage from the distributor and any spillage shall be cleaned from the road surface to avoid flushing and possible fabric movement at these asphalt rich areas. The asphalt cement used as a sealant shall have distributor tank temperature between 300°F and 350°F, except when applying a tack coat to the fabric, the temperature shall not exceed 320°F to avoid damaging the fabric.

409.03.4--Fabric Placement. The fabric shall be placed on the asphaltic sealant as soon as practical and before the adhesion properties of the sealant is lost. The fabric shall be placed as smoothly as possible to avoid wrinkles.

Wrinkles severe enough to cause "folds" shall be slit and laid flat. Small wrinkles which flatten under compaction are not detrimental to performance. The fabric shall be broomed or squeegeed to remove air bubbles and make complete contact with the road surface as recommended by the fabric manufacturer or distributor. The fabric shall be laid straight, however moderate curves can be negotiated by stretching the fabric on the outside of the curve.

Longitudinal and transverse joints shall be made by overlapping the fabric at least six inches. Additional sealant shall be applied to the joints as required and may be applied by hand hose spraying or with mop and bucket if extreme care is taken to not over apply. Transverse joints should be "shingled" in the direction of construction traffic and paving to prevent pick-up. In circumstances where this method is impractical, asphalt pavement or sand spread over the joint will aid in prevention of pick-up.

When recommended by the manufacturer or distributor's technician and/or ordered by the Engineer, the fabric shall be rolled with a pneumatic roller to improve bonding and reduce slippage.

409.03.5--Treatment of Fabric Prior to Overlay. Normally it is not necessary to tack coat the fabric unless there are circumstances such as delay in placement of subsequent course, dust accumulation or insufficient initial application of sealant which would make tack coating desirable. If a tack coat is required by the Engineer, emulsified asphalt shall be applied at a rate of 0.02 to 0.05 gallon of residual asphalt per square yard.

Placement of the subsequent course shall closely follow fabric laydown. In the event that the sealant bleeds through the fabric, it may be necessary to blot the sealant with sand to prevent construction equipment from picking up the fabric. Turning of the paver and other vehicles must be gradual to avoid stripping or damage to the fabric.

If traffic must be maintained on the fabric prior to placement of the subsequent course, it is advisable to spread a small quantity of sand over the fabric and roll with a pneumatic roller to prevent tires from picking up the fabric.

If rain should cause a blistered appearance and bond loss, it shall be corrected by rolling with a pneumatic roller.

409.03.6--Asphalt Pavement Overlay. The overlay shall conform to Sections 401 and 403 except that the mixture shall be delivered to the paver at a temperature of 275°F to 300°F. Temperature of the mix shall in no case exceed 325°F.

409.04--Method of Measurement. Geotextile fabric for underseal, placed in accordance with these specifications and as directed by the Engineer, will be measured by the square yard of surface area. Any overwidth of material installed and additional material required for laps will not be measured.

Asphalt cement for fabric underseal, applied in accordance with these specifications and as directed by the Engineer, will be measured by the gallon in accordance with Subsections 109.01 and 410.04.

Any blotting with sand, rolling to restore bond and application of a tack coat will not be measured for payment and is considered incidental to completion of the work.

409.05--Basis of Payment. Geotextile fabric for underseal will be paid for at the contract unit price per square yard. Asphalt cement for fabric underseal of the kind and grade specified, measured as provided above, will be paid for at the contract unit price per gallon. These prices shall be full compensation for satisfactorily completing the work.

Payment will be made under:

409-A: Geotextile Fabric for Underseal, Type * - per square yard

409-B: Asphalt Cement for Fabric Underseal - per gallon

* When not designated, see Subsection 714.13.

SECTION 410 - BITUMINOUS SURFACE TREATMENT

410.01--Description. This work consists of the construction of a single or multiple layer bituminous surface treatment in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.

410.02--Materials.

410.02.1--Bituminous Material. The type and grade of bituminous materials will be specified in the contract and conform to the applicable requirements of Section 702.

410.02.2--Cover Material. Cover material shall meet the applicable requirements of Subsection 703.14, and the kind and type will be specified in the contract.

Only one type of aggregate or combination of aggregates shall be used on a particular project except with written permission of the Engineer.

Sites for stockpiles of materials shall be grubbed and cleaned prior to storing the aggregates, and the ground shall be firm, smooth, and well drained.

410.03--Construction Requirements.

410.03.1--Prime Coat. The prime coat, when specified, shall meet the requirements of Section 408.

During the period between the application of the prime coat and the bituminous surface treatment, the primed surface shall be kept in continuous repair. All holes, raveled areas, and areas deficient in prime shall be patched and repaired with approved materials.

410.03.2--Seasonal and Weather Limitations. Emulsified asphalt and cut-back asphalt shall be applied only when the air temperature is above 60°F. Asphalt cement shall be applied only when both the air and surface temperatures are above 75°F.

Cut-back asphalt shall not be placed during the period between October 15 and March 1. No prime shall be placed when soil and weather conditions would prevent the proper placement and retention of the materials.

Bituminous materials for surface treatment shall not be placed during the period between November 1 and March 1, nor when weather conditions otherwise prevent the proper placement and retention of the materials.

On projects where completion of seal coats after November 1 or before March 1 is determined to be in the public interest, the Engineer may permit variations from the above under the condition that all the following requirements are met:

- (a) The air temperature is 60°F or higher.
- (b) Asphalt cement used is cut back with naphtha of the type that will yield from 5-10 percent off at 680°F when tested by method AASHTO Designation: T 78 and the naphtha is added at the refinery.
- (c) As an alternate to (b), the Contractor substitutes a rapid setting cationic emulsified asphalt meeting the requirements of AASHTO Designation: M 208.
- (d) Aggregate is satisfactorily air dried in covered storage, or mechanically dried.
- (e) The sun is shining.
- (f) Aggregate is applied immediately behind the distributor.
- (g) No shot is made after mid-afternoon, and rolling is increased as directed for shots made after noon.
- (h) The Contractor retains full responsibility for the acceptable quality of the work within the intent of the contract, these conditions notwithstanding.
- (i) The work is performed under these modifications at no additional cost to

the State.

Blanket authorization will not be given for use of the above modification, but will be given only when completion of the surface treatment would make the facility available for use by public traffic, or for subsequent construction.

Prior to November 1 and after March 1, when the requirements of these specifications are being met, but conditions are less than good for the adhesion of cover aggregate to the bituminous material, the Engineer may permit or require, at no additional cost to the State that the asphalt cement be cut back with naphtha as previously indicated. Less than good placement conditions shall be understood to include, but not limited to: lower than desirable temperature; higher than desirable humidity; surface dampness; or coolness of the foundation or aggregate.

410.03.3--Equipment. The following or equivalent equipment shall be furnished:

410.03.3.1--Bituminous Heating Equipment. This equipment shall heat and maintain the bituminous material within specification requirements without damaging the material. The heating equipment shall be supplied with at least one accurate asphalt thermometer.

410.03.3.2--Distributor. The distributor shall be mounted on pneumatic tires of sufficient width to prevent breaking the surface bond when the tank is fully loaded. It shall be self-propelled and sufficiently powered to maintain the desired speeds during operation. It shall be equipped to evenly heat and maintain the material at the required temperature; have adequate pressure devices and suitable manifolds to provide constant and even distribution for the entire length of the spray bars; and have positive cutoff to prevent dripping from the nozzles. It shall be so constructed that uniform applications may be made at the specified rate on variable widths up to 26 feet. Charts and devices shall be provided by the Contractor for determining the quantity being applied.

410.03.3.3--Rotary Brooms. Rotary brooms shall be constructed to permit the revolutions of the broom to be adjusted to its progression and to permit adjustment of the broom in relation to the surface. The broom bristles shall be stiff enough to sweep clean without injury to the surface.

410.03.3.4--Power Rollers. Steel-wheel rollers shall be self-propelled, rated at 5 to 8 tons, and shall have a weight of at least 200 pounds per inch of roller width. The rollers may be the three wheel type, but the tandem type is preferred.

Pneumatic rollers shall be self-propelled with wheels mounted on two axles in such a manner that the rear tires will not follow in the tracks of the forward group. The rollers shall be capable of applying a minimum of 50 pounds per

square inch contact pressure under each tire, and shall be of a weight that will not damage the base or surface treatment.

410.03.3.5--Trucks. Trucks of sufficient number and size to adequately supply the material shall be furnished.

410.03.3.6--Aggregate Spreaders. Aggregate spreaders shall be constructed so that they can be accurately gauged and set to uniformly distribute the required quantity of aggregate at regulated speed.

410.03.3.7--Other Equipment. Drag brooms shall be furnished and used as conditions dictate.

410.03.4--Preparation of Surface. The entire surface to be treated and at least one foot on each side shall be cleaned by sweeping, blowing, or other methods until all dust, mud, clay lumps, and foreign material is removed. A primed base shall be properly cured and approved prior to application of bituminous material.

410.03.5--Application of Bituminous Material. Bituminous material shall not be applied until the prepared surface has been approved by the Engineer. Where practicable, shots shall be at least 500 feet in length, and longer shots are desirable. No shot shall be in excess of a length which can be covered with aggregate before the bitumen hardens.

The bituminous material shall be uniformly heated and maintained within the specified temperature range during application. All material damaged by heating shall be rejected, and if a section has been treated with damaged material it shall be removed and replaced by the Contractor without additional compensation.

The bituminous material shall be applied with a pressure distributor at the specified rate, and at the temperature specified by the Engineer within the range set out in Subsection 702.11. It shall be uniformly applied full width in one operation unless the Engineer permits it to be applied in narrower widths. The application rate may be varied by the Engineer within the ranges set out in Table 410-A.

The application shall be stopped before the distributor is completely empty, and the length of shots shall be computed so that the application is stopped before it begins to run light. At the beginning of the application, including joints with preceding applications, intersections, and junctions with all pavements, etc., the distributor nozzles shall be operating at full force when the application begins. Building paper or other suitable material shall be used to receive the initial application from the nozzles before the asphalt reaches the road surface at the joint. The material shall be removed immediately after use without spilling asphalt on the road surface.

Spray bar nozzles shall be kept clean at all times, and should one become blocked during application of the bituminous material, the distributor shall be stopped immediately and the nozzle cleaned before proceeding. Bare or light areas shall be immediately made uniform by use of a hand hose or pouring pot.

Due to possible spillage, the transfer of material from the delivery truck to the distributor shall be outside the limits of the roadway. Bituminous material shall not be discharged on the right-of-way when cleaning out the distributor. Any spillage shall be removed from the roadway and right-of-way.

During application of bituminous material, the Contractor shall provide adequate protection to prevent marring or discoloration of pavements, structures, curbs, trees, etc., adjacent to the area being treated.

Longitudinal joints, when permitted, shall be reasonably true to line and parallel to the centerline. The overlap in the application of the bituminous material shall be the minimum to assure complete coverage.

At construction joints, the treatment of the edges shall be blended so that there are no gaps, the elevations are the same, and the joints are free from ridges and depressions.

410.03.6--Application of Cover Coat Material.

410.03.6.1--General. The application of cover material shall immediately follow the application of bituminous material. Adhesion of the cover aggregate to the bitumen is the Contractor's responsibility. The time interval between applications of bituminous material and cover aggregate shall not exceed 20 minutes when the air temperature is below 85°F or 30 minutes when the temperature is 85°F or above.

Aggregate shall be spread directly from approved spreaders. Trucks or spreaders shall not drive on the uncovered bituminous material.

The application rate of cover aggregate will be specified by the Engineer within the ranges set out in Table 410-A. The dry aggregate shall be spread uniformly to cover the bituminous material with the quantity of mineral aggregate specified by the Engineer. All deficient areas shall be covered by additional material. All excess cover material shall be removed from the surface and stockpiled or used as directed.

If needed, approved drag brooms and hand brooms shall be used to distribute the aggregate uniformly before and while the rolling operations are in progress.

The entire application of aggregate shall be rolled as soon as possible after application. Rolling shall be continued and repeated as often as necessary to key

the cover material thoroughly into the bituminous material over the entire surface.

Pneumatic rollers and steel-wheel rollers shall be used in the sequence that will provide the rolling pattern that results in the best adhesion of the aggregate to the bituminous material and the best surface qualities.

Subsequent to the initial application of the aggregate the Contractor shall distribute, as many times as is deemed necessary, loose aggregate over the surface to absorb free bituminous material and to cover areas deficient in aggregate. Immediately following each distribution, the Contractor shall roll the entire surface treatment or seal with a pneumatic-tire roller until the maximum quantity of aggregate is embedded in the bitumen. Rolling in each case shall be at least one complete coverage and as many additional coverages as necessary to properly embed the aggregate. All rolling shall be performed while the temperature is favorable for sealing the aggregate into the bitumen.

In all cases there shall be at least five complete coverages of the entire surface of the treatment with a pneumatic-tire roller.

For double treatments or seals when the Engineer has determined that the maximum quantity of aggregate has been embedded on the first layer, the Contractor shall sweep or otherwise remove all excess material but not displace any embedded aggregate.

410.03.6.2--Interlayers. The application rates of bituminous material and cover aggregate for single surface treatment placed on an existing pavement as an interlayer below hot bituminous pavement shall be as shown on the plans or as directed. Unless otherwise specified or shown on the plans, as soon as the single surface treatment has been applied and satisfactorily rolled, the first overall hot bituminous course shall be placed immediately in order to retain all aggregate of the surface treatment. Compaction of the hot bituminous layer shall consist of a minimum of three complete coverages with the pneumatic roller. The steel-wheel roller will not be required and no formal density tests will be made. The quantity of hot bituminous mixture acceptably used in the layer will be included in measurement for leveling course. Seasonal and temperature limitations will not apply to this type of surface treatment.

410.03.7--Control of Traffic. During the construction of each layer of bituminous surface treatment, the Contractor shall regulate the speed of vehicles and other traffic in order that unnecessary damage to the course will be avoided.

410.04--Method of Measurement. Accepted asphalt for surface treatment will be measured by the gallon as prescribed in Subsection 109.01. Unless otherwise specified, distributor tank measurement will be used. The volume of material over five percent above the quantity ordered for each shot will be deducted from

measured quantities, except that 15 percent will be allowed for irregular areas where hand spraying is necessary.

Aggregate cover material will be measured by the cubic yard (LVM) at the point of delivery on the road. Measurement will be for the actual volume spread. The volume of material over five percent above the quantity ordered for each "spreading" will be deducted from measured quantities, except that 15 percent will be allowed for irregular areas where hand "spreading" is necessary.

The volume of all cover material and the volume of all bituminous material lost, wasted, damaged, or rejected, or applied outside of designated areas, or in excess of the Engineer's directions and tolerances allowed, or contrary to the specifications, will be deducted from measured quantities.

410.05--Basis of Payment. Asphalt for surface treatment will be paid for at the contract unit price per gallon. Aggregate cover material will be paid for at the contract unit price per cubic yard (LVM). The prices thus paid shall be full compensation for completing the work.

Payment will be made under:

- 410-A: Asphalt for Surface Treatment, Grade - per gallon
- 410-B: Coarse Aggregate Cover Material, Size ____, Kind - per cubic yard
- 410-C: Seal Aggregate Cover Material, Size ____, Kind - per cubic yard

TABLE 410-A
BITUMINOUS SURFACE TREATMENTS

Item	Bituminous Material	Gallons / Square Yard	Coarse Aggregate Cubic Feet / Square Yard	Seal Aggregate Cubic Feet / Square Yard
Prime Coat	RC-70, 250; MC-30, 70 250; EA-*; AE-P	0.15 - 0.50		
Tack Coat	RC-70,250 800; RS-1,2, SS-1, SS-1h; AC as in Mix; CSS-1, CSS-1h	0.05 - 0.10		
Single Surface Treatment	AC-10; RC-800; RS-1, 2; CRS-2	AC = 0.36 - 0.42; RC, RS or CRS = 0.47 - 0.52	Size 5, 56 or 6 Slag or Stone = 0.52-0.56	
Single Surface Treatment	AC-10; RC-800; RS-1, 2; CRS-2	AC = 0.34 - 0.40; RC, RS or CRS = 0.42 - 0.47	Size 5 or 6 Gravel = 0.48 - 0.54	
Single Surface Treatment	AC-10; RC-800; RS-1, 2; CRS-2	AC = 0.25 - 0.31; RC, RS or CRS = 0.39 - 0.44		Size 7, 8 or 89 Slag, Stone, Gravel or Expanded Clay = 0.25 - 0.31
Double Surface Treatment 1st Course	AC-10; RC-800; RS-1, 2; CRS-2	AC = 0.30 - 0.42; RC, RS or CRS = 0.40 - 0.49	Size 5, 56 or 6 Slag or Stone = 0.50 - 0.54	
Double Surface Treatment 1st Course	AC-10; RC-800; RS-1, 2; CRS-2	AC = 0.30 - 0.38; RC, RS or CRS = 0.42 - 0.47	Size 5 or 6 Gravel = 0.48 - 0.54	
Double Surface Treatment 2nd Course	AC-10; RC-800; RS-1, 2; CRS-2	AC = 0.27 - 0.40; RC, RS or CRS = 0.39 - 0.47		Size 7, 8 or 89 Slag, Stone, Gravel or Expanded Clay = 0.25 - 0.31

* Emulsified asphalt for prime shall meet the requirements of Subsection 702.12, Table III.

SECTION 413 - CLEANING AND SEALING JOINTS AND CRACKS

413.01--Description. This work consists of routing, sawing and/or cleaning, sealing joints and cracks in existing pavement as designated by pay items in the contract proposal and as detailed on the plans and described herein. All work shall be in reasonably close conformity with these specifications and the details shown on the plans, or as directed.

When called for on the plans, this work shall also consist of saw cutting, cleaning and sealing transverse joints in new bituminous concrete overlays. Bituminous concrete pavement joints shall be constructed over, and in line with, the existing underlying transverse portland cement concrete joints in accordance with plans, specifications, and as directed by the Engineer.

413.02--Materials. Unless otherwise designated on the plans or in the contract documents, the joint sealing material may be cold or hot poured material meeting the requirements of Subsection 707.02.1.

The joint sealing material for sealing transverse joints in new bituminous pavement shall be a hot-poured elastic type conforming to the requirements of 707.02.1.3. The bond breaker tape shall consist of regular masking tape or a suitable bond breaker tape designed for use with hot-poured sealants. The width of the tape may be equal to but not more than 1/8" narrower than the width of the saw cut.

Unless otherwise specified in the plans or in the contract documents, the aggregate materials shall be size 89. The aggregate material shall conform to the applicable requirements of Section 703.

413.03--Construction Requirements.

413.03.1--Equipment. The equipment shall be that necessary for routing, sawing, cleaning and pouring the joint material as specified. When required, heating equipment shall meet the requirements of Subsection 702.03. Pouring equipment shall be subject to the approval of the Engineer and shall be capable of pouring the joints and cracks to the required elevation while the material is at the proper temperature. Cleaning equipment shall consist of mechanical or hand operated devices capable of thoroughly cleaning the joints, cracks and adjacent surfaces to the satisfaction of the Engineer. Air compressors shall be equipped with suitable traps and/or filters capable of removing moisture and oil from the compressed air.

413.03.2--Construction Methods.

413.03.2.1--Cleaning and Sealing Joints and Cracks. Joints and cracks to be sealed shall be cleaned by routing, sawing and/or sand blasting to the minimum

dimensions specified. Other methods of cleaning joints and cracks shall be approved by the Engineer. The surface which is to receive the new joint sealing material shall be dry and free of all lubricants, tar, asphalt, discoloration and stain as well as all other forms of contamination leaving a clean newly exposed surface. The adjacent surfaces of the pavement shall be cleaned to the extent necessary to prevent foreign matter from entering the joint before pouring. If necessary, re-cleaning shall be performed immediately prior to pouring.

Before pouring, suitable baffles shall be inserted in the top portion of the open joint, or other approved methods used as necessary, to control the flow of the material into the joint.

Should a joint or crack be deeper than the required dimension, a backer rod of the appropriate size shall be inserted into the opening to prevent the material from being placed in excess of the required depth.

Cracks shall be cleaned and sealed in the same manner as for joints. The Engineer may permit small cracks to be cleaned only by compressed air and sealed with joint sealing material.

Traffic shall not be allowed to travel over the sealed joints/cracks until the joint sealing material is dry enough to prevent tracking. When approved by the Engineer, the Contractor may place concrete sand or other approved material over the joint/crack to prevent tracking.

413.03.2.2--Cleaning and Filling Joints. Joints to be filled shall be cleaned by routing, sawing and/or sand blasting to the minimum dimensions specified. Other methods of cleaning joints shall be approved by the Engineer. The surface which is to receive the new joint sealing material shall be dry and free of all lubricants, tar, asphalt, discoloration and stain as well as all other forms of contamination leaving a clean newly exposed surface. The adjacent surfaces of the pavement shall be cleaned to the extent necessary to prevent foreign matter from entering the joint before pouring. If necessary, re-cleaning shall be performed immediately prior to pouring.

Before pouring, suitable baffles shall be inserted in the top portion of the open joint, or other approved methods used as necessary, to control the flow of the material into the joint.

Should a joint or crack be deeper than the required dimension, a backer rod of the appropriate size shall be inserted into the opening to prevent the material from being placed in excess of the required depth.

After the joint is filled to the required depth with joint sealing material, add aggregate material until the joint is even with the adjacent roadway.

Traffic shall not be allowed to travel over the sealed joints/cracks until the joint sealing material is dry enough to prevent tracking. When approved by the Engineer, the Contractor may place concrete sand or other approved material over the joint/crack to prevent tracking.

413.03.3--Sawing and Sealing Transverse Joints in Asphalt Pavement.

413.03.3.1--General. The Contractor's operation shall be conducted so that sawcutting of transverse joints, cleaning, and sealing is a continuous operation. The entire sawing and sealing operation shall be completed within seven (7) days after the placement of the final wearing course, unless the approved traffic control plan or sequence of operations provide otherwise. Traffic shall not be allowed on sawed unsealed joints. When intermediate lifts must be exposed to traffic for over seven (7) days, the Contractor shall be required to make an interim 1/8-inch wide saw cut which is one third (1/3) as deep as the hot mix asphalt layer. This interim saw cut does not require sealing. Costs of this interim cut(s) is to be absorbed the pay item for sawing and sealing transverse joints in asphalt pavement.

Saw cutting shall be done only after the hot mix asphalt has cooled to ambient temperature.

413.03.3.2--Sawcutting of Transverse Joints. The Contractor shall sawcut transverse joints in the pattern and to the dimensions shown on the plans or as directed by the Engineer. The sawcut joints shall be directly over the existing portland cement concrete pavement joints and shall be accurately located by a method employing pins and stringline. The pins shall be accurately located prior to paving. Details of the Contractor's method for locating the sawcuts shall be subject to the approval of the Engineer.

The blade or blades shall be of such size and configuration that the desired dimensions of each sawcut can be made with one pass. No spacers between blades will be allowed. Either dry or wet cutting will be allowed.

The transverse sawcut joints shall normally extend the full width of the pavement unless otherwise shown on the plans or directed by the Engineer. Existing transverse joints that are offset at the longitudinal joint by more than one inch, measured between the centers of the joint cavities, shall require separate sawcuts terminating at the longitudinal joint.

413.03.3.3--Cleaning. Dry sawed joints shall be thoroughly cleaned with a stream of air sufficient to remove dirt, dust or deleterious matter adhering to the joint walls or remaining in the joint cavity. Wet sawed joints shall be thoroughly cleaned with a 50 psi minimum, water blast immediately after sawing to remove any sawing slurry, dirt or deleterious matter adhering to the joint walls or remaining in the joint cavity. Wet sawed joints shall be blown with air to

provide dry joint surfaces prior to sealing.

All sawing slurry from the wet sawing process shall be immediately flushed from the pavement surface. Dry dust and material from the dry sawing process shall be blown or brushed off the pavement surface.

The Contractor shall be required to provide protective screening, subject to the approval of the Engineer, if cleaning operations are capable of causing damage to or interference with traffic in adjacent lanes.

413.03.3.4--Sealing. Just prior to sealing, each joint shall be thoroughly cleaned of all foreign material and the joint faces shall be clean and surface dry when the seal is applied.

After cleaning, and just prior to sealing, a bond breaker tape shall be placed in the bottom of the sawcut joint.

Sealant material shall be at the pouring temperature recommended by the manufacturer when applied to the joints. Hot applied sealant material shall be stirred during heating so that localized overheating does not occur.

The sealant shall fill the joint such that, after cooling, the sealed joint conforms to the details shown on the plans or as directed by the Engineer. The pouring shall be performed in such a manner that the material will not be spilled on the exposed surfaces of the asphalt pavement. Any excess material on the surface of the asphalt pavement shall be removed immediately and the pavement surface cleaned. The use of sand or similar material as a cover for the seal will not be permitted. Poured joint sealing material shall not be placed when the air temperature in the shade is less than 50°F., unless approved by the Engineer.

413.04--Method of Measurement. Joint sealer material will be measured by the gallon for separate payment only when the proposal has a pay item for joint material.

Accepted joints and cracks, cleaned, sealed and/or filled, will be measured by the linear foot or mile as indicated in the contract proposal.

Sawed and sealed joints in new asphalt pavement will be measured by the linear foot of joint complete in place and accepted by the Engineer. Sawing, bond breaker tape and joint sealant material will not be paid for as separate items but will be included in the unit price per linear foot for sawing and sealing transverse joints in asphalt pavement.

413.05--Basis of Payment. Joint sealer material will be paid for by the gallon when measured as prescribed above, which price shall be full compensation for all materials, equipment, tools, labor and incidentals necessary to complete the

work.

Joints and cracks, cleaned, sealed and/or filled, will be paid for by the linear foot or mile as prescribed in above, which price shall be full compensation for all materials, equipment, tools, labor and incidentals necessary to complete the work.

Sawing and sealing transverse joints in new asphalt pavement, accepted and measured as prescribed, will be paid for at the contract unit price per linear foot; which price shall be full compensation for locating and transferring the location of existing joints to establish new joint locations, for all required sawing, for furnishing all materials, including bond breaker tape and joint sealant materials, for all cleaning, pouring, trimming, cleanup and disposal of all excess and waste, for protective screening; for all pertinent operations necessary and incidental to the construction as indicated herein, and for all equipment, tools, labor, and incidentals necessary to complete the work.

The cost of maintenance of traffic and protective services as required by the Department's Traffic Control Plan shall be included in the cost of items bid. This shall include all required individual traffic control devices.

Payment will be made under:

- 413-A: Joint Sealer Material - per gallon
- 413-B: Cleaning and Sealing Joints - per linear foot or mile
- 413-C: Cleaning and Sealing Cracks - per linear foot or mile
- 413-D: Cleaning and Filling Joints - per linear foot or mile
- 413-E: Sawing and Sealing Transverse Joints in Asphalt Pavement - per linear foot

SECTION 423 - GROUND-IN RUMBLE STRIPS

423.01--Description. This work consists of grinding rumble strips at the locations indicated on the plan, in accordance with the details on the plans, and the requirements set out herein.

423.02--Blank.

423.03--Construction Requirements.

423.03.1--Equipment. The equipment shall consist of a rotary type cutting head

capable of cutting rumble strips to the dimensions shown on the plans. The cutting head shall have the cutting tips arranged in such pattern as to provide a relatively smooth cut of approximately 1/8 of an inch between peaks and valleys. The cutting head(s) shall be 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.

The finished rumble strips shall be cut to the dimensions as shown on the plans within the allowable tolerance and be perpendicular to the direction of travel. The rumble strips shall be placed in relation to the roadway according to the patterns shown on the plans.

Adequate back-up equipment such as mechanical sweeper/vacuum, water truck, etc. and personnel shall be provided to remove all grindings from the shoulder.

423.03.2--Construction Details. The cutting tool shall be equipped with guides to provide a consistent alignment of each cut in relation to the edge line and to provide uniformity and consistency throughout the project. The alignment of the cuts shall not deviate from the path of the edge line.

When the contract requires shoulder paving, the rumble strips shall be cut into the finished shoulder after the final course has been placed, otherwise, rumble strips shall be cut into the existing shoulder material. The debris/grindings generated from the cutting shall be picked up and removed on a daily basis by use of a sweeper/vacuum or other method approved by the Engineer. The shoulder shall be cleaned prior to opening the adjacent lane to traffic. Any other method of cleaning debris from the shoulder or roadway other than picking up shall be approved by the Engineer prior to beginning construction. The use of the material from the rumble strips as RAP in the composition of hot mix asphalt mixtures shall require approval by the State Materials Engineer.

The Contractor shall demonstrate to the Engineer the ability to achieve the desired surface inside each depression without tearing or snagging the asphalt prior to beginning the work. Areas damaged by the Contractor's operations shall be corrected and/or repaired as directed by the Engineer at no additional cost to the State.

When placed on concrete shoulders, the Contractor shall adjust the spacing of the rumble strips to ensure that the depressions are not cut across a concrete shoulder joint.

This construction operation will encroach on the lane adjacent to the shoulder receiving the rumble strips. Therefore, construction on roadways under traffic will either require a lane closure or be considered as a moving operation. Traffic control shall be handled in accordance with the appropriate standard drawings shown in the plans or contract documents.

423.04--Method of Measurement. Rumble strips, ground-in, completed in accordance with the plans and specifications, will be measured by the mile, which price shall be full compensation for all materials, equipment, tools, disposal of grinding debris, any associated traffic control, and all incidentals necessary to complete the work. Length of measurement will start at the beginning of a continuous series of rumble strips and will terminate at the end of the continuous series. The length used to measure rumble strips will be the horizontal length computed along the stationed control line. Each shoulder on which rumble strips have been ground will be measured separately with the measurements from each shoulder combined to obtain the pay length for rumble strips.

423.05--Basis of Payment. Rumble strips, measured as prescribed above, will be paid for at the contract unit price per mile, which price shall be full compensation for completing the work.

The price for rumble strips shall include the cost of any required maintenance of traffic and protective services.

Payment will be made under:

423-A: Rumble Strips, Ground-In	- per mile
423-B: Rumble Strips, Ground-In, Concrete	- per mile

DIVISION 500 - RIGID PAVEMENT

SECTION 501 - PORTLAND CEMENT CONCRETE PAVEMENT

501.01--Description. This work consists of pavement composed of portland cement concrete, with or without reinforcement as specified, constructed in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and cross sections shown on the plans or established by the Engineer. This work also consist of replacing or repairing damaged or deteriorated dowels and wooden joint filler boards.

501.02--Materials. Materials shall meet the applicable requirements of Division 700 and the following Subsections:

Fine Aggregate	703.01 and 703.02
Coarse Aggregate	703.01 and 703.03
Portland Cement	701.01 and 701.02
Water	714.01
Air Entraining Admixtures & Additives	713.02
Calcium Chloride	714.02
Joint Filler	707.02
Curing Materials	713.01
Reinforcing Steel and Dowel Bars	711.02
Dowel Adhesive	714.11

501.02.1--Composition of Concrete.

501.02.1.1--General. The concrete mix design shall be submitted by the Contractor to the Engineer for approval prior to production. The mix proportions shall be based on a laboratory batch as described below.

- a) The combination of materials shall be those intended for use in the proposed work. Materials shall be from approved sources. Aggregate gradations, specific gravities and bulk densities shall be reported.
- b) Trial mixtures having proportions and consistencies suitable for the proposed work shall be made using the ACI 211.1 as a guide to proportion the mix design.
- c) Trial mixtures shall be designed to produce a slump within $\pm 3/4$ in. of the maximum permitted, and for air-entrained concrete, 6.0 ± 0.5 percent total air content. The temperature of freshly mixed concrete in trial mixtures shall be reported.
- d) For each proposed mixture, at least three compressive test cylinders shall be made and cured in accordance with AASHTO Designation: T 126.

Each change of water-cement ratio shall be considered a new mixture. The cylinders shall be tested for strength in accordance with AASHTO Designation: T 22 and shall meet the required 28 day strength.

- e) The strength of laboratory trial mixes shall exceed 4700 psi.
- f) The laboratory trial batch mixtures shall have been made within the last three months before being submitted for approval.

501.02.1.2--Design of Mix. The mix shall be designed to meet the requirements as set out in the following table.

Design Property	Requirements
Minimum Coarse Aggregate Volume / cubic yard Concrete, %	72
Coarse Aggregate Size	467 or 57
Maximum Water / Cementitious Ratio	0.48
Maximum Slump, inches	3
Total Air Content, %	3 - 6
Minimum Compressive Strength, psi	3500

501.03--Construction Requirements.

501.03.1--Batching Plant and Equipment. Concrete batching and handling equipment shall meet the applicable requirements of AASHTO Designation: M 157.

501.03.2--Blank.

501.03.3--Blank.

501.03.4--Blank.

501.03.5--Placing, Spreading, and Finishing Equipment.

501.03.5.1--Finishing Machine. The finishing machine shall be equipped with at least two oscillating type reverse screeds.

501.03.5.2--Vibrators. Vibrators, for full width vibration, may be the surface pan type or the internal type with either immersed tube or multiple spuds. They may be attached to the spreader, paver, or the finishing machine, or may be mounted on a separate carriage. They shall not come in contact with the joint, reinforcing steel, load transfer devices, subgrade, or side forms. The frequency

of the surface vibrators shall be at least 3,500 impulses per minute, and the frequency of the internal type shall be at least 5,000 impulses per minute for tube vibrators and at least 7,000 impulses per minute for spud vibrators.

When spud type internal vibrators, either hand operated or attached to spreaders or finishing machines, are used adjacent to forms, they shall have a frequency of not less than 3,500 impulses per minute.

501.03.5.3--Slip-Form Paver. Slip-form pavers shall be self-propelled and equipped to spread, strike-off, consolidate, screed, and float-finish the freshly placed concrete so that a minimum of hand-finishing will be necessary. The equipment shall be adjustable as to crown and superelevation, and shall shape and compact the concrete into the required cross section. The crown adjustment shall be readily controllable for accuracy in crown transitions.

The paver shall operate on tracks having sufficient contact area to prevent slippage under load. The length of ground contact per track and the arrangement of tracks shall be adequate to meet the straightedge and other riding quality requirements specified.

Screeding shall be accomplished by using either oscillating screeds or an extrusion device, or a combination thereof.

The slip-form paver shall be equipped with traveling side or trailing forms, of sufficient dimension and strength and of proper shape, to support the concrete laterally for a sufficient length of time during placing and finishing. If trailing forms are used they shall be rigidly supported laterally.

The slip-form paver shall be equipped with automatic guidance and grade controls, which operate by sensing from a taut line set to line and grade.

Variation from the requirements detailed herein may be permitted when approved by the Department, provided the proposed variation is an improved feature for which general acceptance by the industry has been established.

501.03.5.4--Steel Placing Equipment. Equipment, as approved by the Engineer, for machine placement of reinforcement shall be factory made by a recognized manufacturer of construction equipment and shall be capable of positioning the steel at the designated location.

501.03.5.5--Transverse Texturing Device. Transverse texturing shall be produced by either tining or grooving as indicated in the plans or in the contract documents.

Other types of texturing equipment may be approved by the Department provided it produces a texture equivalent to that specified.

501.03.5.5.1--Transverse Tining. This equipment shall be a metal tine finishing device having flat steel wire tines capable of being operated to produce uniform, parallel grooves in newly placed pavement.

501.03.5.5.2--Transverse Grooving. This equipment shall be a self-propelled mechanical sawing device using diamond blades. The blades shall be arranged in such a manner to produce grooves 1/8" wide and 3/16" deep spaced in the following sequence: 3/4-inch, 1 1/8-inch, 5/8-inch, 1-inch, 5/8-inch, 1 1/8 -inch, 3/4-inch in six-inch repetitions across the width of the sawing device.

501.03.6--Miscellaneous Equipment.

501.03.6.1--Concrete Saw. When sawing joints is elected or specified, the Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions using a water-cooled diamond edge saw blade, abrasive wheel, "early entry dry cut" type blade, or other device approved by the Engineer.

501.03.6.2--Forms. Straight side forms shall be metal and have a thickness of at least 7/32 inch and shall be furnished in sections at least 10 feet in length. Forms shall have a depth equal to the specified edge thickness of the pavement and a base width of at least 80 percent of the depth of the forms. Flexible or curved forms of proper radius shall be used for curves of 100-foot radius or less. Flexible or curved forms shall be of a design acceptable to the Engineer. Forms shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base not less than 2/3 the height of the form. Forms with battered top surfaces, and bent, twisted, or broken forms shall be removed from the work. Repaired forms shall not be used until inspected and approved. Forms shall not be built-up more than one inch. The top face of the form shall not vary from a true plane more than 1/8 inch in 10 feet, and the upstanding leg shall not vary from a vertical plane more than 1/4 inch. The forms shall contain provisions for secure setting and for locking the ends of abutting form sections together tightly.

501.03.7--Preparation of Grade. The foundation upon which the concrete pavement is to be placed shall be prepared within the tolerances set out in Subsection 321.03 for at least two feet beyond the proposed pavement edge.

501.03.8--Setting Forms.

501.03.8.1--Base Support. The foundation under the forms shall be hard and true to grade so that the form, when set, will be firmly in contact for its whole length and at the specified grade. A grade at the form line which is found to be below the established grade shall be filled to grade with granular materials or bituminous plant mixture in lifts of 1/2 inch or less for the full width of the base

of the form and at least 18 inches outside the base of the form, and thoroughly compacted. Imperfections or variations above grade shall be corrected by tamping or by cutting as necessary.

501.03.8.2--Form Setting. Forms shall be set sufficiently in advance of where concrete is being placed. After the forms have been set to correct grade, the grade shall be thoroughly tamped, mechanically or by hand, at both the inside and outside edges of the base of the forms. Forms shall be staked into place with at least three pins for each 10-foot section. A pin shall be placed at each side of every joint. Form sections shall be tightly locked and free from play or movement in any direction. The forms shall not deviate from true line by more than 1/4 inch at any point. Excessive settlement or springing of forms under the finishing machine will not be tolerated. Forms shall be cleaned and oiled prior to the placing of concrete.

501.03.8.3--Grade and Alignment. The alignment and grade of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete. When a form has been disturbed or a grade has become unstable, the form shall be reset and rechecked.

501.03.9--Conditioning of Base.

501.03.9.1--Conditioning for Formed Pavement. High areas shall be trimmed to proper elevation. Low areas, within the tolerances set out in Subsection 321.03.7 shall be filled with concrete integral with the pavement. The finished grade of the base shall be maintained in a smooth and compacted condition until the pavement is placed.

Unless the base course is waterproof, it shall be uniformly moist when the concrete is placed.

501.03.9.2--Conditioning for Slip-Form Pavement. The base shall be brought to the tolerances set out in Subsection 321.03.7. If the density of the base is disturbed, it shall be corrected by additional compaction before concrete is placed. The grade shall be prepared sufficiently in advance of the placing of the concrete to avoid delays. If traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately ahead of the placing of the concrete.

Unless the base course is waterproof, it shall be uniformly moist when the concrete is placed.

501.03.10--Handling, Measuring and Batching Materials. The batch plant site, layout, equipment, and provisions for transporting material shall be sufficient to assure a continuous supply of material to the work. Stockpiles shall be built up in layers of not more than five feet in thickness. Each layer shall be completely in place before beginning the next, which shall not be allowed to

"cone" down over the next lower layer. Aggregates from different sources and of different gradings shall not be stockpiled together.

Aggregates shall be handled from stockpiles or other sources to the batching plant in a manner that will assure uniform grading of the material. Aggregates that have become segregated shall not be used until properly reblended. Aggregates contaminated with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Rail shipment requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage. In case the aggregates contain a high or nonuniform moisture content, storage or stockpile periods in excess of 12 hours may be required by the Engineer.

The fine aggregate and each size of coarse aggregate shall be separately weighed into hoppers in the quantities set by the job-mix. Cement shall be measured by weight. Separate scales and hoppers, with a device to indicate the complete discharge of the batch of cement into the batch box or container, shall be used for weighing the cement.

Unless otherwise permitted by the contract, batching plants shall be equipped to proportion aggregates and bulk cement by weight using approved automatic and interlocked proportioning devices.

For on-site mixing, aggregates shall be transported from the batching plant to the mixer in batch boxes, vehicle bodies, or other containers of adequate capacity and construction to properly carry the volume required. Partitions separating batches shall be adequate and effective to prevent spilling from one compartment to another while in transit or being dumped. When bulk cement is used, the Contractor shall use a suitable method of handling the cement from weighing hopper to transporting container so as to assure the correct cement content in each batch. Bulk cement shall be transported to the mixer in separate and tight compartments carrying the full amount of cement required for the batch. Cement in original shipping packages may be transported on top of the aggregates with each batch containing the required number of sacks. Batches shall be delivered to the mixer separately and intact. Each batch shall be dumped into the mixer without loss of cement and, when more than one batch is carried on a truck, without spilling of material from one batch compartment into another.

Water may be measured either by volume or by weight. Unless the water is to be weighed, the water-measuring equipment shall include an auxiliary tank from which the measuring tank shall be filled. The measuring tank shall be equipped with an outside tap and valve to provide for checking the setting, unless other means are provided for readily and accurately determining the quantity of water in the tank. The volume of the auxiliary tank shall be at least equal to that of the measuring tank.

Methods and equipment for adding air entraining agent or other admixtures into the batch shall be approved by the Engineer.

The accuracy for measuring materials shall be in accordance with AASHTO Designation: M 157.

501.03.11--Mixing Concrete. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials, except water, are in the drum. Ready-mixed concrete shall be mixed and delivered in accordance with requirements of Section 804.

When mixed at the site of the work or in a central mixing plant, the mixing time shall be that which will provide a satisfactory mixture, and unless otherwise specified in writing by the State Materials Engineer, the mixing time shall be not less than 50 seconds. When deemed necessary to insure a satisfactory mix, the State Materials Engineer may designate a mixing time suitable to obtain a satisfactory mixture. Four seconds will be added to the specified mixing time if timing starts the instant the skip reaches its maximum raised position. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers is included in the mixing time. The contents of an individual mixer drum shall be emptied before a succeeding batch is placed therein.

The mixer shall be operated at the drum speed shown on the manufacturer's name plate on the mixer. All concrete mixed less than the specified time shall be discarded and disposed of by the Contractor at no cost to the State. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic feet, as shown on the manufacturer's standard rating plate on the mixer, except that an overload of up to 10 percent may be permitted provided concrete test data for strength, segregation, and uniform consistency are satisfactory, and provided no spillage of concrete takes place.

The batch shall be so charged into the drum that a portion of the mixing water enters in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first 15 seconds of the mixing period. The throat of the drum shall be kept free of accumulations that might restrict the free flow of materials into the drum.

Mixed concrete from a central-mixing plant shall be transported in truck mixers, truck agitators, or nonagitating trucks having approved bodies. The elapsed time from when water is added to the mix until the concrete is deposited at the site of the work shall not exceed 30 minutes (45 minutes when a retarder is used) when the concrete is hauled in nonagitating trucks, or 60 minutes when hauled in truck mixers or truck agitators.

Retempering concrete by adding water or by other means will not be permitted. However, when concrete is delivered in transit mixers or agitators and if

permitted by the Engineer, additional water may be added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements, provided all these operations are performed within 45 minutes after the initial mixing operation and the total amount of water in the concrete does not exceed the mix design amount. Concrete that exceeds the maximum slump at time of placement shall not be used. Admixtures for increasing the workability or for accelerating the set will be permitted only when specifically provided for in the contract, or when permitted in writing by the Engineer.

501.03.12--Limitations of Mixing. Except in emergencies, no concrete shall be mixed or placed when the natural light will be insufficient for finishing. In case of an emergency, the Engineer may permit finishing during periods of insufficient light provided adequate and approved lighting is furnished by the Contractor.

Concrete shall not be placed on a frozen foundation, nor shall frozen aggregate be used in the concrete.

During periods of cold or expected cold weather, the limitations for beginning a concrete pour and the limitations for temperature control of the mix and its components shall be in accordance with the provisions of Subsection 804.03.16.1.

During periods of hot weather or arid atmospheric conditions the provisions of Subsection 804.03.16.2 shall be applicable.

501.03.13--Placing Concrete.

501.03.13.1--General. Concrete shall be mechanically spread in an approved manner so as to distribute the concrete uniformly without segregation. On roadside areas such as driveways and parking areas for weigh stations or roadside parks, etc. and on other small or irregular areas the concrete may be placed by other approved methods.

The rate of delivery of the concrete shall be such that the interval between the discharge of the successive loads shall not exceed 20 minutes, and when air temperature is 90°F or higher the interval shall not exceed 15 minutes. Concrete that has begun to set up shall not be placed in the work.

All concrete materials that may fall on or be worked into the surface of a completed slab shall be removed immediately by approved methods.

501.03.13.2--Formed Pavement. The concrete shall be deposited on the grade in a manner that will require as little rehandling as possible.

For paneled pavement, placing shall be continuous between transverse joints

without the use of intermediate bulkheads. For continuously reinforced pavement, placing shall be continuous between construction joints without use of intermediate bulkheads. Necessary hand spreading shall be performed with shovels and not rakes. Workers shall not be allowed to walk in the freshly mixed concrete with boots or shoes coated with earth or foreign substances.

When concrete is to be placed adjoining a previously constructed lane of pavement and mechanical equipment will be operated upon the existing lane of pavement, that lane shall have attained the age of 14 days, exclusive of days on which the air temperature does not reach 35°F, or shall have attained a flexural strength of 600 pounds per square inch. If only light finishing bridges, or other similar light equipment, is partially carried on the existing lane, paving in the adjoining lanes will be permitted after three days.

Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies, by means of vibrators inserted in the concrete. Vibrators shall not come in contact with a joint assembly, reinforcing steel, the base, or a side form. In no case shall the vibrators be operated longer than 15 seconds in one location.

Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them, but shall not be dumped onto a joint assembly unless the hopper is well centered on the joint assembly.

The Contractor shall have available at all times materials for the protection of unhardened concrete in the event of rain.

501.03.13.3--Slip-Form Pavement. The Contractor shall have sufficient forms available on the project for use in the event of an emergency.

In order that the concrete may be properly protected against the effects of rain before it has sufficiently hardened, the Contractor shall have available at all times materials for the protection of the edges and surface of the unhardened concrete. Protective materials shall include standard metal forms, or wood planks having a nominal thickness of at least two inches and a nominal width of not less than the thickness of the pavement, and covering material such as burlap or cotton mats, curing paper, or plastic sheeting material. When rain appears imminent, all paving operations shall stop, and all available personnel shall begin placing forms against the sides of the pavement and covering the surface of the unhardened concrete with the protective covering.

The concrete shall be of uniform consistency and placed, shaped, consolidated, and float finished by an approved slip-form paver. The slip-form paver shall be operated off of a taut stringline or wire set by the Contractor to true grade and alignment, except that if the grade at each form line, plus the width of the track of the paver, has been constructed within the tolerance allowed at the form line in

Subsection 321.03.7 the automatic control devices on the paver will not be required.

The equipment shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Vibration shall be accomplished with vibrating tubes or arms working in the concrete or with a vibrating screed or pan operating on the surface of the concrete. No appreciable slumping of the in-place concrete will be allowed, and, if necessary, forms shall be trailed behind the paver to prevent slumping. If trailing forms are used, they shall be rigidly supported laterally.

The slipform paver shall be operated with as nearly a continuous forward movement as possible. If, for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall be stopped immediately.

Where sections of pavement are to be subsequently abutted with other lanes of pavement involving longitudinal or nearly longitudinal joints, the concrete adjacent to these joints shall be placed and finished as required by standard paving methods or by use of false forms, adjacent to the slip forms. The false forms shall be metal of sufficient gage to maintain the proper shape and continuity of the form line and shall be approved by the Engineer. The use of false forms shall be subject to satisfactory performance. If the Contractor is able to construct the pavement without measurable edge slump or misalignment, the Engineer may waive the use of the false form.

When required, bracing of the forms shall be accomplished so there will not be more than 10 feet of unbraced false forms. False forms shall remain in place of a minimum of 90 minutes or until forms can be removed without damaging the adjacent concrete.

501.03.14--Test Specimens. The Contractor shall furnish the concrete necessary for test specimens. The specimens shall be made and cured as specified in Mississippi Test Method: MT-5.

501.03.15--Strike-Off of Concrete and Placement of Reinforcement.

501.03.15.1--General. Reinforcing steel shall be free from dirt, oil, paint, grease, mill scale, and loose or thick rust which could impair bond of the steel with the concrete.

501.03.15.2--Bar Mat Reinforcement. When the pavement is placed in two layers, the entire width of the bottom layer shall be struck off to the length and depth that will permit the sheet of bar mat to be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the bottom layer, after which the top layer shall be placed,

struck off, and screeded. All concrete in the bottom layer which has been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at no additional costs to the State. When the pavement is placed in one layer, the reinforcement may be placed in the plastic concrete after spreading, by approved mechanical or vibratory means, or it may be positioned in advance of concrete placement on supports that will withstand, without displacement, all depositing, spreading, and vibrating operations.

501.03.15.3--Continuous Reinforcement. Steel for continuously reinforced pavement shall be placed by the first of the following methods or conditionally by the second method:

- (a) Steel shall be placed sufficiently in advance of the paving operation. It shall be supported on approved chairs, positioned, and tied in accordance with the plans.
- (b) Machine placement of steel for slip-form paving will be permitted provided the Contractor satisfactorily demonstrates that the equipment used will position the steel in accordance with the plans with the exception that transverse bars will be permitted to be placed on top of longitudinal bars.

501.03.16--Joints. Joints shall be constructed of the type and dimensions and at the locations required by the plans, or as directed.

Sawing of joints shall commence as possible after the concrete has hardened and before uncontrolled shrinkage cracking occurs. The saw blades, and skid plates if early entry method is used, shall be changed as often as necessary to control and minimize spalling/raveling. A sufficient number of saws, replacement blades and skid plates shall be available at the project site to insure that the sawing operations will proceed until completion without interruption.

Any damage to the concrete resulting from the sawing operations shall be corrected immediately after the sawing is complete at no additional costs to the State.

501.03.16.1--Longitudinal Joints. Deformed steel tie bars or transverse bars of specified length, size, spacing, and material shall be placed perpendicular to the longitudinal joints. They shall be placed by approved mechanical equipment or rigidly secured by chairs or other approved supports to prevent displacement. Tie bars shall not be painted or coated with asphalt or other material, or enclosed in tubes or sleeves.

When adjacent lanes of pavement are constructed separately, longitudinal construction joints shall be constructed in accordance with the details shown on the plans. Tie bars, except those made of rail steel, may be bent at right angles

against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed.

The longitudinal center joint shall be installed so that its ends are in contact with transverse joints, if any.

Longitudinal joints shall be constructed by sawing or forming in accordance with the plans.

501.03.16.2--Transverse Expansion Joints. The expansion joint filler shall be continuous from form to form and shaped to the subgrade and to the keyway along the form. Preformed joint filler shall be furnished in lengths equal to the pavement width or equal to the width of one lane. Damaged or repaired joint filler shall not be used unless approved by the Engineer.

The expansion joint filler shall be held in a vertical position. An approved installing bar, or other device, shall be used if required to secure preformed expansion joint filler at the proper grade and alignment during placing and finishing of the concrete. Finished joints shall not deviate more than one-fourth inch in the horizontal alignment from a straight line. If joint fillers are assembled in section, there shall be no offsets between adjacent units. Plugs of concrete will not be permitted within the expansion space.

501.03.16.3--Transverse Contraction Joints. Transverse contraction joints shall consist of planes of weakness created by forming or sawing grooves in the surface of the pavement as shown on the plans and shall include load transfer assemblies when specified.

501.03.16.4--Transverse Construction Joints. Transverse construction joints shall be constructed when there is an interruption of more than 30 minutes in the concreting operation. Construction joints shall not be constructed within 10 feet of expansion joints, contraction joints, or planes of weakness. If sufficient concrete has not been mixed at the time of interruption to form a slab of at least 10 feet long, the excess concrete back to the last preceding joint shall be removed and disposed of as directed.

501.03.16.5--Load Transfer Devices. When dowel assemblies are used, the dowels shall be held in position parallel to the surface and center line of the slab.

For the slip-form method of concrete placement, dowel bars may be placed in the full thickness of pavement immediately following the paver with a vibratory inserter in lieu of using dowel assemblies. The vibratory dowel bar inserter shall be approved by the Engineer. The inserter shall vibrate the dowels into place accurately, at the proper location both vertically and longitudinally. An oscillating surface correcting beam shall follow immediately behind the inserter to correct surface deformation caused by the inserter. When a dowel bar inserter

is used, a skewed joint may be permitted with the approval of the Engineer.

The entire length of each dowel will be thoroughly coated with an approved lubricant to prevent adherence to the concrete.

501.03.16.6--Dowel Replacement. When designated on the plans, dowel replacement work shall consist of replacing damaged or deteriorated dowels in reconstructed contraction joints and both dowels and wooden joint filler boards in reconstructed expansion joints.

Dowel bars shall be the size and length designated on the plans. Wooden joint filler board shall conform to the dimensions shown on the plans.

New expansion boards shall be drilled to fit the new dowels installed. Special care shall be taken to ensure that all dowels in the joint remain parallel to the surface of the concrete.

501.03.17--Final Strike-Off, Consolidation and Finishing.

501.03.17.1--Sequence. The sequence of operations shall be the strike-off and consolidation, floating and removal of laitance, straight-edging, and final surface finish.

Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be used. A second screed shall be provided for striking off the bottom layer of concrete if reinforcement is used and the pavement is placed in two layers.

The screed for the surface shall be at least two feet longer than the maximum width of the slab to be struck off. It shall be of approved design, sufficiently rigid to retain its shape, and be constructed of metal or of other suitable material shod with metal.

Consolidation shall be attained by the use of a suitable vibrator or other approved equipment.

In operation the screed shall be moved forward with a combined longitudinal and transverse shearing motion, and manipulated so that neither end is raised from the side forms during the striking off process. If necessary, this shall be repeated until the surface is of uniform texture, true to grade and cross section, and free from porous areas.

In general, the addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted. If the application of water to the surface is permitted, it shall be applied as a fog spray by means of approved spray equipment.

501.03.17.2--Finishing at Joints. The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material, and also under and around all load transfer devices, joint assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated as required in Subsection 501.03.13.2.

After the concrete has been placed and vibrated adjacent to the joints, the finishing machine shall be brought forward, operating in a manner to avoid damage or misalignment of joints. If uninterrupted operation of the finishing machine, to, over, and beyond the joints causes segregation of concrete, damage to, or misalignment of the joints, the finishing machine shall be stopped when the front screed is approximately eight inches from the joint. Segregated concrete shall be removed from in front of and off the joint, and the front screed shall be lifted and set directly on top of the joint and the forward motion of the finishing machine resumed. When the second screed is close enough to permit the excess mortar in front of it to flow over the joint, it shall be lifted and carried over the joint. Thereafter, the finishing machine may be run over the joint without lifting the screeds, provided there is no segregated concrete immediately between the joint and the screed or on top of the joint.

501.03.17.3--Machine Finishing. Unless otherwise specified, full width vibration shall be performed. If uniform and satisfactory density of the concrete is not obtained by the vibratory method at joints, along forms, at structures, and throughout the pavement, the Contractor shall furnish equipment and methods which will produce pavement conforming to the specifications.

501.03.17.4--Hand Finishing. Unless otherwise specified, hand finishing methods, other than the hand floating method described below, will not be permitted except under the following conditions:

In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade when the breakdown occurs.

Narrow widths or areas where operation of mechanical equipment is impractical may be finished by hand methods.

501.03.17.5 Floating. After the concrete has been struck off and consolidated, it shall be further smoothed and trued by means of a longitudinal float, using one of the following methods as specified:

- (a) **Hand Method.** The hand-operated longitudinal float shall be at least 12 feet long and six inches wide, properly stiffened to prevent flexibility and warping. The longitudinal float, operated from foot bridges spanning but not touching the concrete, shall be worked with a sawing motion while held in a floating position parallel to the road centerline,

and passing gradually from one side of the pavement to the other. Movement ahead along the centerline of the pavement shall be in successive advances of not more than one-half the length of the float. Excess water and soupy material shall be wasted over the sides on each pass.

- (b) **Mechanical Method.** The mechanical longitudinal float shall be of a design approved by the Engineer, and shall be in good working condition. The float shall be accurately adjusted to the required crown, and coordinated with the adjustments of the transverse finishing machine so that a small amount of mortar is carried ahead of the float at all times. The float shall pass over each area of pavement at least two times, but excessive operation over a given area will not be permitted. Excess water and soupy material shall be wasted over the sides on each pass.

As an alternative to the mechanical method, the Contractor may use a machine composed of a cutting and smoothing float, or floats, suspended from and guided by a rigid frame. The frame shall be carried by four or more visible wheels riding on and constantly in contact with the side forms, or track line of a slip-form paver.

If necessary, following one of the preceding methods of floating, long-handled floats having blades at least five feet long and six inches wide may be used to smooth and fill in open-textured areas in the pavement. Long-handled floats shall not be used to float the entire surface of the pavement in lieu of, or to supplement, one of the preceding methods of floating. When strike-off and consolidation are done by the hand method and the crown of the pavement will not permit the use of the longitudinal float, the surface shall be floated transversely by means of the long-handled float. Care shall be taken not to work the crown out of the pavement during the operation. After floating, excess water and laitance shall be removed from the surface of the pavement by a straightedge 10 feet or more in length. Successive drags shall be lapped one-half the length of the blade.

501.03.17.6--Straight-Edge Testing and Surface Correction. After the floating has been completed and while the concrete is still plastic, the surface of the concrete shall be tested with a 10 foot straightedge. For this purpose the Contractor shall furnish and use an accurate 10-foot straightedge swung from handles three feet longer than one-half the width of the slab. The straightedge shall be held in contact with the surface in successive positions parallel to the road centerline and the whole area gone over from one side of the slab to the other as necessary. Advance along the road shall be in successive stages of not more than one-half the length of the straightedge. All depressions found shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for

smoothness. Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge, and the slab conforms to the required grade and cross section.

501.03.18--Final Finish. The surface finish of the concrete shall be that designated on the plans and in the bid schedule of the contract. If a finish is not designated, the finish shall be a drag finish.

501.03.18.1--Drag Finish. This finish shall consist of a uniform surface of gritty texture produced by dragging a seamless strip of damp burlap or cotton fabric longitudinally along the full width of pavement. For pavement 16 feet or more in width, the drag shall be mounted on a bridge which travels on the forms or track line. The dimensions of the drag shall be such that a strip of burlap or fabric at least three feet wide is in contact with the full width of pavement surface while the drag is used. The drag shall consist of at least two layers of burlap with the bottom layer approximately six inches wider than the upper layer. The drag shall be maintained in a condition that will produce a surface of uniform appearance with corrugations approximately one-sixteenth inch in depth. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags substituted.

501.03.18.2--Broom Finish. A broom finish shall be applied when the water sheen has practically disappeared. The broom shall be drawn from the center to the edge of the pavement with adjacent strokes slightly overlapping. The brooming operations shall produce corrugations in the surface that are uniform in appearance and not more than 1/16 inch in depth. Brooming shall be completed before the concrete has set to a degree that the surface will be torn or unduly roughened by the operation. The finished surface shall be free from rough and porous areas, irregularities, and depressions. Brooms shall be of the quality, size, and construction and operated so as to produce a surface finish meeting the approval of the Engineer. Subject to satisfactory results being obtained and approval of the Engineer, the Contractor will be permitted to substitute mechanical brooming in lieu of manual brooming as herein described.

501.03.18.3--Belt Finish. When straight-edging is complete and the water sheen has practically disappeared and just before the concrete becomes nonplastic, the surface shall be belted with a two-ply canvas belt eight inches wide and at least three feet longer than the pavement width. Hand belts shall have suitable handles to permit controlled, uniform manipulation. The belt shall be operated with short strokes transverse to the road centerline and with a rapid advance parallel to the center line. Subject to satisfactory results being obtained and approval of the Engineer, the Contractor will be permitted to substitute mechanical belting in lieu of manual belting as herein described.

501.03.18.4--Transverse Tine Finish. The surface shall first be given a drag finish. After completion of the drag finish, the pavement shall be given an

additional texture by transverse tining.

The final surface texture shall be produced with a metal tine finishing device meeting the requirements of Subsection 501.03.5.5. The texturing device shall be so constructed and operated as to produce uniform parallel grooves perpendicular to the centerline of the pavement 1/2 inch on centers and having a depth of 1/8 inch, plus or minus 1/32 inch.

The metal tine device shall be operated by approved mechanical means when texturing main roadway pavement lanes. Manual methods may be used for texturing small irregular areas inaccessible to the texturing machine.

The depth of the finished grooves will be determined by the use of a standard commercial tire tread depth measuring gauge with 1/32 inch graduations that can be easily and accurately read, a brass wire brush, and a steel straightedge approximately 1/4 inch x 1 inch x 12 inches. The Contractor shall furnish this equipment for use by and subject to the approval of the Engineer. The method of measuring the depth of grooves will be as set out in Department SOP.

If for any reason the concrete hardens to the extent that the tining equipment does not provide grooving in accordance with these requirements, or if rainfall damages the finish and the Engineer permits the concrete to remain in place, the Contractor shall use other approved devices such as saws to construct the grooves substantially in accordance with the requirements specified herein.

501.03.18.5--Transverse Grooved Finish. After the concrete has cured for a minimum of seven (7) days, areas to be transverse grooved shall be grooved with a sawing device meeting the requirements of Subsection 501.03.5.5.2. Grooves shall be perpendicular to the centerline of the roadway and extend as close as possible to the edge but in no case more than two (2) feet from the edge, gutter line, etc. The tolerance for the width of the groove is +1/16" to -0" and the tolerance for the depth and spacing of the grooves is $\pm 1/16$ ".

501.03.18.6--Edging at Forms and Joints. After the final finish, but before the concrete has taken its initial set, the pavement along each side of each slab, and on each side of transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints shall be worked with an approved tool and rounded to the radius required by the plans. A well-defined and continuous radius shall be produced and a smooth, dense, mortar finish obtained. The surface of the slab shall not be unduly disturbed by tilting of the tool during use.

At all joints, all tool marks appearing on the slab adjacent to the joints shall be eliminated by brooming the surface. In doing this, the rounding of the corner of the slab shall not be disturbed. All concrete on top of the joint filler shall be completely removed.

All joints shall be tested with a straightedge before the concrete has set, and correction made if one side of the joint is higher than the other, or if they are higher or lower than the adjacent slabs.

501.03.19--Surface Test. It is the intent of these specifications that the finished surface will have good riding qualities.

Profiles of the mainline pavement surface will be established, evaluated and the pavement surface corrected, as necessary, so that the final surface variances shall not exceed a profile index of 30 inches per mile per segment. Mainline pavement is defined as all pavements other than shoulders, parking lanes, ramps, tapers, acceleration and deceleration lanes, bridge decks, and bridge approach slabs. Determination of the profile index will be in accordance with test methods established by the Department.

A California profilograph meeting the requirements as set out in Section 401 shall be furnished and operated by the Contractor under supervision of the Engineer to provide recorded data to establish the profile index and identify locations requiring correction. Surface profile shall be obtained in the wheel path of each travel lane.

During initial paving operations, either when starting up or after a long shut down period, the pavement surface will be tested with profilograph as soon as the concrete has cured sufficiently to allow testing. Membrane curing damaged during the testing operation shall be repaired by the Contractor. The purpose of this testing is to aid the Contractor and the Engineer in evaluating the paving methods and equipment. For the purpose of determining pavement smoothness and contract price adjustment for rideability, each day's production will be subdivided into sections which terminate at bridges, transverse joints or other interruptions. Each section will be sub-divided into segments of 528 feet. Where a segment less than 528 feet occurs at the end of a section, it will be combined with the preceding 528-foot segment for calculation of the profile index. The last 15 feet of a day's production may not be obtainable until the paving operation is continued and for this reason may be included in the subsequent segment. If a day's paving is less than 50 feet, it shall be tested using the ten-foot straightedge, and shall be included in the subsequent day's production profile.

A profile index will be determined for each segment as inches per mile in excess of the "Zero" blanking band which is simply referred to as the "Profile Index". From the profilogram of each segment, the scallops above and below the "Zero" blanking band are totaled in tenths of an inch. The totaled count of tenths is converted to inches per mile to establish a smoothness profile index for that segment.

In addition to the above requirements for the profile index, all areas represented by high points having deviations in excess of 0.3 inch in 25 feet shall be removed

by the Contractor utilizing grinding methods and equipment specified. Deviations in excess of 0.3 inch will be determined from the profilogram in accordance with Department test methods.

After correcting individual deviations in excess of 0.3 inches in 25 feet, corrective action shall be made to reduce the profile index to 30 inches per mile per segment or less.

On those segments where corrections are made, the pavement will be tested to verify that corrections have produced a profile index of 30 inches per mile per segment or less.

Corrections shall be made using an approved profiling device or by removing and replacing the pavement as directed by the Engineer. Corrective work shall be performed at no additional cost to the State.

Each area or section of pavement removed shall be at least 10 feet in length and at least the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 10 feet in length shall also be removed and replaced. The new surface shall be textured as specified in the contract.

Where surface corrections are made, the Contractor shall reestablish the surface texture to a uniform texture equal in roughness to the surrounding uncorrected pavement. This work shall be at no additional cost to the State.

Corrective work shall be completed prior to determining pavement thickness.

501.03.19.1--Diamond Grinding. Grinding of concrete surfaces shall consist of diamond grinding the existing portland cement concrete surface to remove surface distortions to achieve the specified surface smoothness requirements.

501.03.19.1.1--Equipment. The grinding equipment shall be a power driven, self-propelled machine that is specifically designed to smooth and texture portland cement concrete surfaces with diamond blades. The effective wheel base of the machine shall not be less than 12.0 feet. It shall have a set of pivoting tandem bogey wheels at the front of the machine and the rear wheels shall be arranged to travel in the track of the fresh cut pavement. The center of the grinding head shall be no further than 3.0 feet forward from the center of the back wheels.

The equipment shall be of a size that will cut or plane at least 3.0 feet wide. It shall also be of a shape and dimension that does not encroach on traffic movement outside of the work area. The equipment shall be capable of grinding the surface without causing spalls at cracks, joints, or other locations.

501.03.19.1.2--Construction. The construction operation shall be scheduled and

proceed in a manner that produces a uniform finish surface. Grinding will be accomplished in a manner to provide positive lateral drainage by maintaining a constant cross-slope between grinding extremities in each lane.

The operation shall result in pavement that conforms to the typical cross-section and the requirements specified in Subsection 501.03.19.1.3. It is the intent of this specification that the surface smoothness characteristics be within the limits specified.

The Contractor shall establish positive means for removal of grinding residue. Solid residue shall be removed from pavement surfaces before it is blown by traffic action or wind. Residue shall not be permitted to flow across lanes used by public traffic or into gutters or drainage facilities, but may be allowed to flow into adjacent ditches.

501.03.19.1.3--Finished Concrete Surface. The grinding process shall produce a pavement surface that is smooth and uniform in appearance with a longitudinal line type texture. The line type texture shall contain parallel longitudinal corrugations that present a narrow ridge corduroy type appearance. The peaks of the ridges shall not be more than 1/16 inch higher than the bottoms of the grooves.

The finished pavement surface will be measured for riding quality. The grinding shall produce a mainline riding surface which does not exceed either the specified profile index or the specified bump and dip limit.

501.03.20--Curing and Protection. Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be covered and cured in accordance with one of the following methods. On hot or windy days, and when directed by the Engineer, the surface of the fresh concrete shall be kept damp by fogging with water until the normal curing operation can be performed. In all cases in which curing requires the use of water, the curing shall have prior right to all water supplies. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 hour between stages of curing or during the curing period. Unless otherwise specified, the curing period shall be 72 hours.

501.03.20.1--White Pigmented Membrane. The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place. The curing compound shall not be applied during rainfall or when there is a water sheen on the pavement.

Curing compound shall be applied under pressure at the rate of one gallon to not more than 150 square feet for all surface finishes except transverse grooving. For transverse groove finishes, the application shall be at the rate of one gallon to not more than 120 square feet. The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigments uniformly dispersed throughout the vehicle. During application, the compound shall be stirred continuously by effective mechanical means. Hand spraying of odd widths or shapes and on concrete surfaces exposed by the removal of forms will be permitted. Curing compound shall not be applied to the faces of joints to be sealed, and those faces shall be cured by other approved means for at least 72 hours.

The curing compound shall be of such character that the film will harden within 30 minutes after application. Should the film become damaged from any cause within the curing period, the damaged portions shall be repaired immediately with additional compound.

Upon removal of side forms, the sides of the slabs exposed shall be protected immediately to provide a curing treatment equal to that provided for the surface.

501.03.20.2--White Polyethylene Sheeting. The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting. The pieces used shall be lapped at least 18 inches. The sheeting shall be so placed and weighted down that it will remain in direct contact with the surface covered. The sheeting shall be wide enough to extend 18 inches beyond the edges of the slab being cured.

501.03.20.3--Curing in Cold Weather. When concrete is being placed and the air temperature may be expected to drop below 35°F, a sufficient supply of straw, hay, grass, or other suitable blanketing material shall be provided to protect the work. The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather, and all concrete injured by frost action shall be removed and replaced at no additional cost to the State. The Department reserves the right to perform destructive or nondestructive testing for evaluation of damage caused by cold weather.

501.03.20.4--Protection of Pavement. The Contractor shall protect the pavement from both public traffic and traffic caused by employees and agents. This shall include watchmen to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, or crossovers, etc. The plans or special provisions will indicate the location and type of device or facility required to protect the work and provide adequately for traffic. The Contractor shall have materials available at all times to protect unhardened concrete from rain.

All damage to the pavement, occurring prior to final acceptance, shall be repaired

or the pavement replaced.

501.03.21--Removing Forms. Except for auxiliary forms used temporarily in widened areas or unless otherwise provided, forms shall not be removed from freshly placed concrete until it has set for at least 12 hours. Forms shall be removed carefully so as to avoid damage to the pavement. After the forms have been removed, the sides of the slab shall be cured as outlined in one of the methods indicated in the previous subsection. Honeycombed areas shall be satisfactorily repaired.

501.03.22--Sealing Joints. Joints to be sealed shall be filled with joint sealing material meeting the requirements of Subsections 707.02.1.3 or 707.02.1.4, as shown on plans, and Subsection 707.02.1.5 before the pavement is opened to traffic, and as soon after completion of the curing period as is feasible.

501.03.22.1--Cleaning. Joints shall be clean, dry and frost free when the sealant is applied. Formed joints shall be thoroughly cleaned to remove all form release agents, curing compound residue, laitance, or any other foreign materials. All joints shall be thoroughly cleaned by sandblasting each face separately to the depth of the sealer and backer rod. The cleaning operation of existing joints shall ensure that the concrete joint surfaces which are to receive the new joint sealant and backer rod are free of all debris, discoloration and stain; as well as any and all other forms of contamination. If a clean exposed concrete surface cannot be obtained by sandblasting, the joints shall be refaced with a power driven concrete saw with diamond and/or abrasive blades. The refaced joints shall be washed and sandblasted as set forth above. Immediately prior to installation of the backer rod, the joints shall be cleaned with compressed air which is free of moisture and oil. Wiping fingers on cleaned surface of joints shall not show evidence of dust. The joints shall be completely free of sand, oil and moisture.

Material in expansion joints shall be removed to the required depth with a power saw and/or router in such a manner as not to damage the expansion material which is to remain in place.

501.03.22.2--Installing Backup Material. After the final cleaning, a resilient rod type backup material shall be installed with a positioning device to insure conformity with the dimensions shown on the plans. The rod shall be compatible with the sealant and no bond or reaction shall occur between the rod and the sealant.

501.03.22.3--Installing Sealant. The installation of the sealant is to be performed as soon after placing the backer rod as reasonably possible to ensure that joints are still clean and dry. In the event a joint does become contaminated, damp, or wet, the backer rod is to be removed and the joint cleaned and dried with a new backer rod reinstalled prior to placing the sealant. The ambient temperature at time of placement must be 40°F or higher. The sealant shall be

applied by pumping only. The pump shall be of sufficient capacity to deliver the necessary volume of material to completely fill the joint to the specified width and height of sealant in one pass. The nozzle shall be of sufficient size and shape to introduce the sealant inside the joint with sufficient pressure to prevent voids occurring in the sealant and force the sealant to make contact with the joint faces. The sealant shall be tooled to provide the specified recess depth, thickness and shape as shown on the plans. Sufficient force or pressure shall be applied to the sealant in this tooling operation to force the sealant against the joint faces to ensure satisfactory wetting and bonding. The sealant shall be placed to reasonably close conformity with dimensions and shape shown on the plans. Any unreasonable deviation will be cause for rejection and necessary corrective action will be made by the Contractor.

501.03.22.4--Cleaning Pavement. After a joint has been sealed, all surplus sealant on the pavement shall be promptly removed.

501.03.23--Opening to Traffic. The Engineer will decide when the pavement may be opened to traffic. The pavement shall not be opened to traffic until test specimens have attained a compressive strength of 3500 pounds per square inch. If such tests are not performed, the pavement shall remain closed to traffic for 14 days, or 28 days if Type IP cement or Type I or II portland cement with fly ash is used, from the date of placement. Prior to opening to traffic, the pavement shall be cleaned.

501.03.24--Tolerance in Pavement Thickness. The thickness of the pavement will be determined from cores taken in accordance with Subsection 501.03.24.1 and tested in accordance with Subsection 700.03. Holes remaining in the pavement after coring shall be completely filled by the Contractor, at no additional cost to the State, with concrete of the same quality as used to construct the pavement.

It is anticipated that when portland cement concrete pavement is placed over an asphalt treated base, the concrete may penetrate the asphalt treated base. Volumes of portland cement concrete that penetrate the asphalt treated base will not be included in the volume of concrete pavement to be paid for.

When cores are taken to determine the thickness of portland cement concrete pavement, it is anticipated a layer of asphalt treated base will adhere to the bottom of the core. Prior to determining the thickness of the portland cement concrete pavement, all particles of asphalt treated base will be removed from the bottom of the core. Measurement of core thicknesses will be made from top of portland cement concrete pavement to the top of the asphalt treated base.

501.03.24.1--Thickness Determination. For the purpose of establishing adjusted unit prices for pavement, units to be considered separately are defined as 1000 linear feet of pavement in each traffic lane. Each traffic lane will be

divided into units of 1000 feet of pavement, excluding exceptions and omissions, beginning at the end of the pavement nearest the Beginning of Project. The last unit in each lane will be the length remaining except that if the length is less than 100 feet, it will be included in the previous unit. Each project under the same contract will be separated into units independently of the other projects. One core will be taken at random by the Department in each unit. When the measurement of the core from a unit is not deficient more than 0.2 inch from the plan thickness, full payment will be made. When the measurement is deficient by more than 0.2 inch and not more than 1.0 inch from the plan thickness, that measurement will represent the one-third of the section in which it falls, and one additional core will be taken at random in each of the remaining thirds of the section. The average thickness of these three cores will determine the average thickness for that unit. An adjusted unit price as provided in Subsection 501.05.2 will be paid for the unit represented.

Other areas such as intersections, entrances, crossovers, ramps, etc., will be considered as separate units, and the thickness of each unit will be determined separately. Small irregular unit areas may be included as part of another unit. The areas to be included in each unit will be predetermined. At points the Engineer may select at random in each unit, one core will be taken for each 1000 square yards of pavement, or fraction thereof, in the unit. If the core taken is not deficient more than 0.2 inch from the plan thickness, full payment will be made. If the core is deficient in thickness by more than 0.2 inch but not more than 1.0 inch from plan thickness, two additional cores will be taken at random from the area represented and the average of the three cores determined. If the average measurement of these three cores is not deficient more than 0.2 inch from the plan thickness, full payment will be made. If the average thickness of the three cores is deficient more than 0.2 inch but not more than 1.0 inch from the plan thickness, an adjusted unit price as provided in Subsection 501.05.2 will be paid for the area represented by these cores.

In calculating the average thickness of the pavement, measurements which are in excess of the specified thickness by more than 0.2 inch will be considered as the specified thickness plus 0.2 inch, and measurements which are less than the specified thickness by more than 1.0 inch, excluding exploratory cores, will be considered as the specified thickness minus 1.0 inch in the average.

When the measured thickness of a core is less than the plan thickness by more than 1.0 inch, the actual thickness of the pavement in this area will be determined by taking exploratory cores at not less than 10 foot intervals parallel to the centerline in each direction from the affected location until in each direction a core is found which is not deficient by more than 1.0 inch. Areas found deficient in thickness by more than 1.0 inch will be evaluated by the Engineer; and if in the judgment of the Engineer, the deficient areas warrant removal, they shall be removed and replaced with pavement of the thickness shown on the plans without cost to the Department. If the Engineer determines that the deficient

areas do not warrant removal, the pavement may be left in place with no payment to the Contractor, or may be removed and replaced at the Contractor's option. Exploratory cores for deficient thickness will not be used in averages for areas for adjusted unit price.

501.03.24.2--Alternate to Coring. For contracts on which less than 7,500 square yards of pavement is placed, cores will not be taken unless the State Materials Engineer elects to do so.

For such contracts, the Project Engineer's measurements will be used to determine the pavement thickness as follows:

The Engineer will accurately measure, by taut stringline or instrument from referenced grades, and record the grade on which the pavement is to be placed. After the pavement is in place, the Engineer will accurately measure and record the grade of the top of the pavement above each point where the initial measurements were made.

From the measurements thus made, the thickness of each area will be determined, unless the State Materials Engineer elects to take the cores as provided in this subsection. In the latter case the measurements made from cores will govern.

501.04--Method of Measurement. Concrete pavement will be measured by the square yard complete in place and accepted. The width for measurement will be the plan width, including widening where called for, or as otherwise authorized in writing by the Engineer. The length will be measured horizontally in accordance with Section 109.

Where integral or raised edge curb is constructed, the width of the pavement will include the width of the curb.

When specified for payment, expansion joints complete and accepted, will be measured by the linear foot.

Reinforced concrete lug anchors will be measured by the linear foot.

Reinforcement and other materials for which no pay item is included in the contract will not be measured for separate payment.

When rehabilitating existing pavement, dowels will be measured per each and wooden joint filler board shall be measured by the linear foot. All concrete removed will be measured by the square yard under pay item 202-B.

When a pay item is included in the contract, transverse grooving will be measured by the square yard, complete in place and accepted. For bridge decks,

the quantity will be computed by measuring the limits of transverse grooving shown in the plans. When not shown, the quantity will be computed by measuring the bound area between the face of barrier rail and the length of the span. For concrete and bridge end pavements, the quantity will be computed by measuring by the limits of transverse grooving shown in the plan. When not shown, the quantity will be computed by measuring the bound area between the edge of pavement and the length of the pavement.

501.05--Basis of Payment.

501.05.1--General. Concrete pavement will be paid for at the contract unit price per square yard, adjusted when applicable in accordance with Subsections 501.05.2 and 501.05.3.

Expansion joints will be paid for at the contract unit price per linear foot.

Reinforced concrete lug anchors will be paid for at the contract unit price per linear foot.

Transverse grooving, measured as prescribed above, will be paid for at the contract unit price per square yard, which price shall be full compensation for all grinding, cleaning and sweeping; and for all labor, equipment, tools and incidentals necessary to complete the work.

When rehabilitating existing pavement, dowel bars and expansion board will be paid for at the contract unit price per each and linear foot, respectively, which shall be full compensation for furnishing all labor, equipment, tools and materials to complete the work. No separate payment will be made for cutting off dowel bars left in the existing pavement. Unless otherwise noted, the price for dowel replacement work shall include the cost of continuous maintenance of traffic and protective services as required by the Department's Traffic Control Plan. This shall include all required individual traffic control devices.

The prices thus paid shall be full compensation for completing the work.

Payment will be made under:

- 501-A: ____ " Reinforced Cement Concrete Pavement,
 Type, Designation Finish - per square yard
- 501-B: ____ " Plain Cement Concrete Pavement, Type,
 Designation Finish - per square yard
- 501-C: ____ " Continuously Reinforced Cement Concrete
 Pavement, Type, Designation Finish - per square yard

Section 501	Section 501
501-D: Expansion Joints with Dowels	- per linear foot
501-E: Expansion Joints without Dowels	- per linear foot
501-F: Concrete Lug Anchors	- per linear foot
501-G: Dowels, Drilled and Installed	- per each
501-H: Dowels, Installed	- per each
501-I: Joint Filler, Wooden Board	- per linear foot
501-K: Transverse Grooving	- per square yard

501.05.2--Price Adjustments for Thickness. Where the average thickness of pavement determined in accordance with Subsection 501.03.24.1, or with Subsection 501.03.24.2, is deficient in thickness by more than 0.2 inch, but not more than 1.0 inch, payment will be made at an adjusted price as specified in the following table:

Thickness Deficiency Inches	Proportional Part of Contract Price Allowed
0.00 to 0.20	100 percent
0.21 to 0.30	80 percent
0.31 to 0.40	72 percent
0.41 to 0.50	68 percent
0.51 to 0.75	57 percent
0.76 to 1.00	50 percent

When the thickness of an area of pavement is deficient by more than 1.0 inch and, in the judgment of the Engineer, the deficient area should be removed, the area shall be removed and replaced at no additional costs the State with pavement of the specified thicknesses. If, in the judgment of the Engineer, the deficiency does not warrant removal, the deficient area may be left in place with no payment to the Contractor, or may be removed and replaced at no additional cost to the Department, at the Contractor's option.

501.05.3--Price Adjustments for Smoothness. When the profile index is less than or equal to twenty-two inches per mile (22.0 inches / mile) per segment, a unit price increase will be added. The following schedule lists the Profile Index range and the corresponding contract price adjustment.

Profile Index Inches Per Mile Per Segment	Adjustment Price Per Square Yard Of PCC Pavement
less than 10.0	plus \$ 0.26
10.0 to 14.0	plus \$ 0.20
14.1 to 18.0	plus \$ 0.13
18.1 to 22.0	plus \$ 0.07
22.1 to 30.0	\$ 0.00
Over 30.0	\$ 0.00 (With Correction of $PI \leq 30.0$)

The adjusted unit price will be computed using the contract unit price of the portland cement concrete pavement. This adjusted unit price will apply to the total area of the 0.1-mile segment for the lane width represented by the profilogram.

For concrete pavement other than main-line pavement, the surface will be tested using a 10-foot straightedge at locations selected by the Engineer. The variation of the surface from the testing edge of the straightedge between any two contacts, longitudinal or transverse with the surface, shall not exceed 1/4 inch. Irregularities exceeding the specified tolerances shall be corrected, at no additional cost to the State, by the Contractor with an approved profiling device or by other means as directed by the Engineer. Following correction, the area will be retested to verify compliance with the specified tolerances.

**SECTION 502 - PORTLAND CEMENT CONCRETE
BRIDGE END PAVEMENT**

502.01--Description. This work consists of bridge end pavement of portland cement concrete with reinforcement as shown on the plans, constructed in one course on a prepared base in accordance with these specifications, and in reasonably close conformity with the lines, grades, thickness, and cross section shown on the plans or as directed.

502.02--Materials. On bituminous paving contracts, concrete for this work may be Class "B" Structural Concrete meeting the applicable requirements of Subsection 804.02. Sampling and testing of concrete for acceptance and control purposes shall be in accordance with Subsection 804.02.3.

Reinforcing steel shall meet the requirements of Subsection 711.02.

502.03--Construction Requirements.

502.03.1--General. The requirements specified for concrete pavement in Section 501, shall apply in all respects to bridge end pavement except where otherwise indicated in the specific requirements below, or on the plans.

When the plans specify a certain thickness of hot mix asphalt under the bridge end pavement, the Contractor may substitute Class "B" Structural Concrete base in lieu of the hot mix asphalt. The concrete base shall be constructed in one course on a prepared base in accordance with these specifications, and in reasonably close conformity with the lines, grades, thickness, and typical cross-sections as shown on the plans or as directed. The concrete base will be allowed to cure 24 hours prior to placement of the bridge end pavement. A one-inch premolded expansion joint will be required along the face of the paving bracket. See Section 403 for measurement and payment of substituted concrete base material.

502.03.2--Specific Requirements.

502.03.2.1--Final Screeding and Finishing. The final screeding shall be performed by hand methods. The concrete shall be screeded longitudinally using the bridge floor for a gauge on one end, and a temporary bulkhead cut and securely installed true to crown and grade on the other end. In the event the concrete pavement, adjacent to the bridge end pavement, has been previously poured, the end of the pavement shall be used as a gauge in lieu of the temporary bulkhead. The final finish of the bridge end pavement shall be that designated on the plans. If a finish is not designed, the finish shall be transverse tined finish.

502.03.2.2--Joints. Concrete bridge end pavement shall be constructed monolithically, unless construction joints are specifically indicated on the plans.

502.04--Method of Measurement. Portland cement concrete bridge end pavement, complete in place and accepted, will be measured as specified in Subsection 501.04.

502.05--Basis of Payment. Portland cement concrete bridge end pavement will be paid for at the contract unit price per square yard in accordance with the methods as provided in Subsection 501.05. The prices thus paid shall be full compensation for completing the work.

Payment will be made under:

502-A: Reinforced Cement Concrete Bridge End Pavement - per square yard

SECTION 503 - REPLACEMENT OF CONCRETE PAVEMENT

503.01--Description. This work consists of replacing continuously reinforced

and/or reinforced (jointed) concrete pavement and the removal and replacement of base materials at locations designated on the plans or as determined by the Engineer all in accordance with the plans and specifications.

503.02--Materials. Materials shall meet the requirements of Subsection 700.01 and the following Subsections of Division 700, Materials and Tests.

Portland Cement	701.01 and 701.02
Fine Aggregate	703.01 and 703.02
Coarse Aggregate	703.01 and 703.03
Concrete Admixtures	713.02
Water	714.01
Concrete Reinforcement Bars	711.02
Longitudinal Joint Filler	707.02
Curing Materials	713.01

503.03--Construction Requirements.

503.03.1--Equipment. Equipment shall meet the requirements set out in Section 501 for hand placement and finishing portland cement concrete pavement. Batching and mixing equipment shall meet the applicable requirements of Section 804. On-site mixers or truck mixers will be permitted.

503.03.2--Removal of Existing Pavement.

503.03.2.1--General. Existing pavement shall be removed in accordance with details shown on the plans and as specifically set out herein. Removal will be measured for payment as set forth in Section 202. The Contractor shall dispose of the concrete in accordance with Section 201.

Equipment and methods used in all of the work shall not damage any of the underlying base and materials that are to remain in place. All materials which are removed from the roadway shall be disposed of daily.

503.03.2.2--Reinforced Concrete Pavement. The removal of existing reinforced concrete pavement shall be accomplished by sawing the full thickness of the pavement along the edge of the repaired areas as shown on the plans and/or as directed by the Engineer.

503.03.2.3--Continuously Reinforced Concrete Pavement. The pavement within the lap area shall not be disturbed, damaged, or removed until the continuity of the concrete and steel has been severed between the failed area and the lap area. This shall be accomplished by sawing the full thickness of the pavement along the edge of the lap area. Jack hammers used for cutting and removal of the concrete in the lap area shall not exceed 20 pounds.

The concrete in the lap area shall be removed in such a manner to result in a near vertical face at the saw line of the repair area. A chipping type removal is required to prevent spalling the bottom of the pavement to remain. Any spalling in excess of one and one-half inches shall be corrected by enlarging the repair area at no additional cost to the State. All shattered and damaged concrete shall be removed and the exposed faces cleaned.

The reinforcing steel in the lap area shall not be bent more than four inches in twenty inches from its original position. Where more than 10 percent of the steel is damaged in the lap area along any one edge of a removed area, the patch shall be enlarged at no additional cost to the State to provide the specified lap. Where less than 10 percent of the steel is damaged, the bars may be repaired by welding.

The steel shall be inspected for excessive rusting and evidence of distress during the removal process. The Engineer may enlarge the patch to remove deteriorated steel from the lap area. When the patch is enlarged by the Engineer, payment will be made for such removal.

503.03.3--Removal of Base Material. Base material referred to herein and on the plans shall be all types of material below the pavement that requires removal and backfill. The material shall be removed to the dimensions and depths designated by the Engineer. Removal of all undercut materials shall be in accordance with Section 202 and measured for payment by the square yard of base. The Contractor shall dispose of the material in accordance with Section 201.

503.03.4--Installation of Smooth Dowel Bars. Smooth dowel bars shall be installed in accordance with details shown on the plans and as specifically set out herein.

The commercial grout system used shall be one of the systems specified in Subsection 714.11.7. Installation and acceptance procedures are also included therein.

After the dowel bars are installed, the placement of reinforcing steel and any other work that may disturb the setting of the grout will not be permitted.

503.03.5--Installation of Tie Bars. The tie bars, except when directed otherwise on the plans, shall be No. 5 deformed bars, 30 inches long, placed on 24-inch centers and grouted using a commercial grout. The drilled holes shall be partially filled with an epoxy grout and the tie bars inserted to ensure that the holes are completely filled.

The commercial grout system used shall be one of the systems specified in Subsection 714.11.7. Installation and acceptance procedures are also included therein.

After the tie bars are installed, the placement of reinforcing steel and any other work that may disturb the setting of the grout will not be permitted.

503.03.6--Base and Pavement Replacement. Repair of the base and pavement shall conform to the requirements set forth herein and details shown on the plans. The exposed faces of the concrete pavement, the soil cement base and/or polyethylene covering the base repair shall be sprayed with water just prior to pouring the new slab.

The applicable provisions of Section 501 shall be adhered to with the following exceptions:

- (a) Concrete. Structural concrete for pavement repair shall be made of Portland cement or Portland cement with additives and/or admixtures. The use of additives or admixtures shall be in accordance with the manufacturer’s instructions. The Contractor shall submit a proposed concrete mix design to the Mississippi Department of Transportation Materials Division for approval at least two weeks prior to use on the project.

This concrete shall also meet the requirement for a compressive strength of 3500 psi within 72 hours. To meet these requirements, a Type F or G high range water reducing admixture shall be used. If the ambient temperature is less than 50°F, the addition of a Type C or E acceleration admixture shall be used. The usage of admixtures shall be in accordance with manufacturer’s instructions.

Air Content 3 to 6%
Slump 8” maximum*

* No requirement for an initial slump before the addition of the high range water reducer.

Field verification trial mix results must be provided to the Engineer prior to placement if there is no previous data to verify strength.

- (b) Forms. The forms may be metal or wood. Where at all possible, the forms shall be metal. Metal form shall meet the requirements of Subsection 501.03.6.2 and the wood forms shall be made of 2 x 8 lumber. Forms shall be graded to a specified elevation as directed by the Engineer.
- (c) Longitudinal Joints. Where a repair area is required to extend across a longitudinal joint, a preformed or sawed longitudinal joint shall be constructed and sealed as shown on the plans or as directed by the Engineer.

- (d) Consolidating and Finishing. All concrete shall be thoroughly consolidated by internal vibration. Finishing may be performed by either machine or hand methods. All patches less than 20 feet in length shall be screeded longitudinally unless otherwise permitted by the Engineer.

The surface of the pavement shall be finished as designated elsewhere in the contract and in accordance with the applicable portions of Section 501.

The screed shall be metal of a type used on bridges for finishing short patches and may be a mechanical or bridge type on long patches exceeding 20 feet. All replacement concrete shall be checked longitudinal with a 10-foot straightedge in accordance with Subsection 501.03.19 for concrete pavement other than main-line pavement.

- (e) Curing and Protection. Concrete cylinders used to represent the minimum compressive strength shall be field cured and cured by the same methods used on that portion of the roadway it represents. If the ambient temperature is less than 50°F, the field cured cylinders shall be placed in an insulated box.

The concrete repair area shall be cured up until the time of opening to traffic. All exposed surfaces, including vertical surfaces, shall be cured immediately after finishing operations have been completed.

Curing and protection shall be in accordance with Subsection 501.03.20. White pigmented curing compound shall be used and the sprayer shall be equipped with a container having a capacity of not less than five gallons and maintain a constant pressure by mechanical means. Curing time shall be continued until the concrete has attained the required compressive strength as evidenced by test specimens.

- (f) Concrete Saw Cuts. The saw cut shall be at the locations and depth shown on the plans.
- (g) Contraction Joint Assembly. Contraction joint assemblies shall be installed as per the details shown in the plans.
- (h) Concrete Placement. Limitations on placing continuously reinforced concrete pavement are set forth in the following schedule:

**CONCRETE PAVING SCHEDULE
DURING DAYTIME HOURS**

<u>Predicted High Temperature</u>	<u>Hours of Daytime Placement</u>
Below 70°F	Daylight hours
70° - 84°F	12:00 Noon to Sundown
85° - 89°F	1:30 PM to Sundown
90°F & Above	3:00 PM to Sundown

Note: The National Weather Service's predicted high temperature for the day shall govern. Unless lighting provisions have been made for nighttime work, sufficient time must be allowed for the finishing operation prior to sundown but no less than 30 minutes will be permitted.

**CONCRETE PAVING SCHEDULE
DURING NIGHTTIME HOURS**

During nighttime operations, concrete pours may be made anytime between sundown and sunrise without regard to predicted high temperatures.

503.03.7--Opening to Traffic. Upon approval of the Engineer, the traffic lane shall be opened within 72 hours and may be opened when a 2500 psi compressive strength is obtained as verified by cylinder break. Side forms shall be removed and the shoulder repaired with hot mix asphalt pavement, and the area cleared of equipment and waste materials prior to opening to traffic.

The sampling and testing frequency for concrete test cylinders shall be at least two cylinders per day per section of lane for which an individual lane closure is effected and concrete pavement is replaced.

The Contractor must make arrangements to have the concrete compressive cylinders tested by an acceptable commercial laboratory. Results from laboratory tests may be accepted verbally to expedite the opening of traffic to a section of closed roadway, but the Contractor must furnish the Engineer with certified test reports within three days. Any misrepresentation of test cylinders which allows traffic to be opened in areas that did not meet minimum requirements will result in the Contractor removing and replacing the repair(s) represented by the cylinder at no additional cost to the State.

503.04--Method of Measurement. Replacement of the concrete pavement will be measured for payment by the square yard complete in place. Saw cuts will be measured for payment by the linear foot when a pay item is included in the contract proposal. Concrete for base repair will be measured by the cubic yard

complete in place. Smooth dowel bars and tie bars will be measured per each complete in place.

No separate measurement will be made for reinforcing steel, wire mesh, longitudinal joints, polyethylene sheeting and hot bituminous pavement for repair of shoulders and maintenance of traffic items required.

The plans may also provide for welding of the reinforcing steel as an optional method available to the Contractor. This method reduces the width of the lap area from 20 inches to eight inches which will reduce the size of the repair areas. If the Contractor elects to use the optional method, the subsequent reduction in plan quantities will not be justification for adjustment of contract unit prices as provided in Subsection 104.02.

503.05--Basis of Payment. The accepted quantities of saw cuts, concrete for base repairs, smooth dowel bars, tie bars, and concrete pavement will be paid for at the contract unit prices which shall be full compensation for completing the work, furnishing all labor, equipment, tools, materials, and bituminous plant mix required for shoulder repair. Removal and disposal of pavement and base materials shall be made under appropriate items under Section 202.

The price for each item of work shall include the cost of continuous maintenance of traffic and protective services as required by the Department's Traffic Control Plan. This shall include all required individual traffic control devices.

Payment will be made under:

- 503-A: ____ " and Variable Type Concrete Pavement,
 Type Finish - per square yard
- 503-B: Saw Cut, Longitudinal Joints - per linear foot
- 503-C: Saw Cut, ____ " - per linear foot
- 503-D: Concrete for Base Repair - per cubic yard
- 503-E: Tie Bars, No. ____ Deformed, Drilled and Epoxied
 or Grouted - per each
- 503-F: ____ " Smooth Dowel Bars, Drilled and Epoxied
 or Grouted - per each

SECTION 508 - SILICONE SEALED JOINTS

508.01--Description. This work shall consist of cleaning and sealing joints in

accordance with the plans and these specifications.

508.02--Materials. The silicone sealant material used in this construction shall meet the requirements of Subsection 707.02.1.4. The backer rod shall meet the requirements of Subsection 707.02.1.5.

508.03--Construction Requirements.

508.03.1--Cleaning. Joints shall be clean, dry and frost free when the sealant is applied. Formed joints shall be thoroughly cleaned to remove all form release agents, curing compound residue, laitance, or any other foreign materials. All joints shall be thoroughly cleaned by sandblasting each face separately to the depth of the sealer and backer rod. The cleaning operation of existing joints shall ensure that the concrete joint surfaces which are to receive the new joint sealant and backer rod are free of all debris, discoloration and stain; as well as any and all other forms of contamination. If a clean exposed concrete surface cannot be obtained by sandblasting, the joints shall be refaced with a power driven concrete saw with diamond and/or abrasive blades. The refaced joints shall be washed and sandblasted as set forth above. Immediately prior to installation of the backer rod, the joints shall be cleaned with compressed air which is free of moisture and oil. Wiping fingers on cleaned surface of joints shall not show evidence of dust. The joints shall be completely free of sand, oil and moisture.

Material in expansion joints shall be removed to the required depth with a power saw and/or router in such a manner as not to damage the expansion material which is to remain in place.

508.03.2--Installing Backup Material. When shown as a requirement of the contract and after the final cleaning, a resilient rod type backup material shall be installed with a positioning device to ensure conformity with the dimensions shown on the plans. The rod shall be compatible with the sealant and no bond or reaction shall occur between the rod and the sealant. Unless otherwise designated, the rod diameter shall be one-eighth of an inch (1/8") greater than the joint width.

508.03.3--Installing Silicone Sealant. The installation of the sealant is to be performed as soon after placing the backer rod as reasonably possible to ensure that joints are still clean and dry. In the event a joint does become contaminated, damp, or wet, the backer rod is to be removed and the joint cleaned and dried with a new backer rod reinstalled prior to placing the sealant. The ambient temperature at time of placement must be 40°F or higher. The sealant shall be applied by pumping only. The pump shall be of sufficient capacity to deliver the necessary volume of material to completely fill the joint to the specified width and height of sealant in one pass. The nozzle shall be of sufficient size and shape to introduce the sealant inside the joint with sufficient pressure to prevent voids occurring in the sealant and force the sealant to make contact with the joint faces.

This is especially critical in large joints. The sealant, if not of the self leveling type, shall be tooled to provide the specified recess depth, thickness and shape as shown on the plans. Sufficient force or pressure shall be applied to the sealant in this tooling operation to force the sealant against the joint faces to ensure satisfactory wetting and bonding. The sealant shall be placed to reasonably close conformity with dimensions and shape shown on the plans. Any unreasonable deviation will be cause for rejection and necessary corrective action will be made by the Contractor.

508.03.4--Cleaning Pavement. After a joint has been sealed, all surplus sealant on the pavement shall be promptly removed.

508.03.5--Opening to Traffic. Traffic shall not be permitted over the sealed joints until the sealant is tack free.

508.04--Method of Measurement. Silicone sealed joints will be measured by the linear foot.

508.05--Basis of Payment. Silicone sealed joints will be paid for at the contract unit price per linear foot, which shall be full compensation for satisfactorily completing the work.

The price for this work shall include the cost of continuous maintenance of traffic and protective services as required by the Department's Traffic Control Plan. This shall include all required individual traffic control devices.

Payment will be made under:

508-A: Silicone Sealed Joints - per linear foot

SECTION 510 - REPAIR OF CONCRETE PAVEMENT

510.01--Description. This work consists of surface preparation, including cleaning, and placement of polymer concrete in spalled areas of concrete pavement, or other areas directed by the Engineer, in accordance with these specifications and in reasonably close conformity with the lines and grades of the existing pavement.

510.02--Materials. The polymer concrete shall be one of the approved materials listed in the MDOT's "Approved Sources of Materials" under the List of Approved Rapid Setting Commercial Grouts and Patching Compounds for use in the repair of punch-outs (spall repairs) in concrete pavements.

510.03--Construction Requirements.

510.03.1--Surface Preparation. All spall areas one inch in diameter or larger shall be cleaned and prepared for receiving the polymer concrete. The Contractor shall remove all loose, cracked or deteriorated concrete from the spalled areas using a mason or shop hammer and if necessary, a jack hammer not larger than 20 pounds. Spalled areas shall first be sand blasted, or other method approved by the Engineer, until concrete exhibits an obvious color change, and then air blasted to remove all loose debris.

510-03.2--Manufacturing and Placing of Polymer Concrete. Spalled areas must be completely dry prior to priming and placement of polymer concrete. Priming resin shall be mixed according to the manufacturer's published recommendations. The entire area of spalls plus an additional two inches around the circumference of the area shall be primed using a brush. Priming resin may be allowed to gel prior to placing resin/aggregate. The resin shall be mixed with the aggregate in accordance with the manufacturer's recommendation until the aggregate is thoroughly wetted with the resin.

The Contractor shall first fill, tamp, trowel and screed the spalled area parallel to the centerline of the roadway, then apply a surface coat of dry graded aggregate and tamp into wetted aggregate to provide skid resistance.

The polymer concrete shall be allowed to cure for two (2) hours prior to opening the area to traffic.

510.04--Method of Measurement. Graded aggregate and resin used in polymer concrete pavement repair of spalled areas will be measured by the cubic foot of aggregate and by the gallon for resin. Catalyst will not be measured for separate payment.

510.05--Basis of Payment. Graded aggregate and resin, measured as provided above, will be paid for at the contract unit price per cubic foot of aggregate and gallon of resin, which price shall be full compensation for all surface preparation, cleaning, priming, placing of polymer concrete, disposal of all surplus material; and for all materials, equipment, tools, labor and incidentals necessary to complete the work.

Payment will be made under:

510-A: Graded Aggregate - per cubic foot

510-B: Resin - per gallon

SECTION 511 - PREROLLING EXISTING PAVEMENT

511.01--Description. This work consists of prerolling existing pavement to

determine construction procedures required under other provisions of the contract.

511.02--Blank.

511.03--Construction Requirements.

511.03.1--Equipment. The roller shall consist of a single-axle trailer-type roller or a loaded truck having a single rear axle. The axle shall be loaded to a gross weight equal to or greater than the maximum legal load for a tandem axle on the highway on which the project is located but not to exceed 25 tons, and the Contractor shall provide the means necessary for the Engineer to determine that these weight requirements are being met.

The wheels shall be equipped with pneumatic tires capable of being inflated to a minimum inflation pressure of 100 psi. Tires may contain liquid if the Contractor so desires. The Contractor shall provide the Engineer with verification of gross axle weight and tire pressures.

If a trailer type roller is used, it shall be towed by a rubber tired prime mover capable of maintaining a speed of two miles per hour. The prime mover with roller attached shall be capable of executing a 180° turn within a width of 30 feet.

511.03.2--Protection. Rolling shall be conducted so as to avoid damage to existing structures and features designated to remain. Damage to such structures and features shall be repaired or the items replaced, in kind, at no additional cost to the State. The loaded roller shall not encroach upon bridge end pavement or, in the absence of bridge end pavement, within 20 feet, or greater distance when directed, of bridge abutments except under specific authority granted to cross a bridge.

Live loadings on any bridge shall not exceed the statutory loading permitted on the bridge except the Department may consider an overload permit for individual cases. All pertinent information, including proposed frequency and size of loadings and type and exact location of bridges shall be furnished the Department in order that a comprehensive study may be made.

Loading limits on bridges under the jurisdiction of agencies other than the Department are set by the agencies, independently of statutory limits and the Department.

511.03.3--Construction Methods. The sequence of rolling and the operating speed of the roller shall meet the approval of the Engineer. A roller coverage is defined as a single pass over a single traffic lane.

Generally, one coverage will be sufficient to determine slabs requiring treatment.

Extra coverages may be required when necessary to confirm slabs to be treated.

It is the intent of this specification to hold the rolling operation to a minimum, and rolling coverages considered unnecessary by the Engineer are to be omitted.

Prerolling may begin as early as 4:00 A.M. and continue as long as the surface temperature of the pavement remains below 85°F.

The above work shall be included and correlated with the general sequence of operations set out in Subsection 403.03.5.2.

511.04--Method of Measurement. Prerolling will be measured by the square yard. The area of prerolling will be computed by using the horizontal length along the centerline of the roadway and the width, unless otherwise specified, of the concrete pavement in or under the traffic lane being prerolled.

Only areas designated by the Engineer to be rolled will be measured for payment. Test rolling as provided in Section 412 will not be included in measurement for prerolling.

511.05--Basis of Payment. Prerolling will be paid for at the contract unit price per square yard, which shall be full compensation for completing the work.

Payment will be made under:

511-A: Prerolling - per square yard

SECTION 512 - PRESSURE GROUTING CONCRETE PAVEMENT

512.01--Description. This work consists of locating unstable concrete pavement, drilling of holes and the pumping of a slurry type grout mixture to stabilize and underseal the pavement. The grout mixture shall form a hard and insoluble mass that will effectively fill the voids. Pavement that remains unstable after an initial undersealing and stabilizing attempt shall be re-grouted as directed by the Engineer.

When a hot mix asphalt overlay is required, it shall be the Contractor's responsibility to schedule operations in such a manner that the first course of overlay will be placed at the earliest practicable time and no later than fourteen days after the pavement has been stabilized.

When designated on the plans, this work shall also consist of drilling holes in the shoulder adjacent to cracks at the edge of the pavement and the pumping of a slurry type grout mixture to fill the cracks to the surface of the cement treated shoulder. Unless otherwise specified, Type 1 grout shall be used. If in the

Engineer's opinion, the type of grout being used proves to be unsatisfactory, the Contractor shall switch to a Type 5 grout at no change in contract price.

512.02--Materials. shall meet the follows requirements:

Materials used in the work shall meet the requirements specified in the following sections or subsections:

Portland Cement Types I or III	701
Calcium Chloride, Type I	714.02*
Fly Ash, Class C or F	714.05
Water	714.01.1 and 714.01.2
Fine Aggregate	703.18**
Limestone Dust	512.02.1

- * The Materials Engineer may approve other commercially available accelerators which may be substituted for calcium chloride.
- ** Fine aggregate shall meet the requirements of Subsection 703.18 except that mortar making properties are not required.

512.02.1--Limestone Dust. The source of the material shall be approved by the Engineer and meet the following gradation requirements:

SIEVE	PERCENT PASSING
No. 30	95-100
No. 200	20-100

512.02.2--Proportioning Grout Mixture. The bid item will designate the type or types of grout mixture which shall consist of proportions listed in the table below. The mixing water shall be that quantity which will produce a grout of such consistency that the time of efflux from the flow cone will be a minimum of 16 seconds and a maximum of 22 seconds. Upon approval of the Engineer, a wetting agent may be added to the water to reduce surface tension and increase flowability of the grout mixture.

The consistency will be determined by Mississippi Test Method MT-56. Cement, fly ash, limestone dust, and/or fine aggregate may be added in the proper proportions to a mixed batch to produce the required consistency provided the cement factor is not reduced to less than specified.

**GROUT MIXTURES
PERCENT BY WEIGHT OF DRY MATERIALS**

DRY MATERIALS	TYPES					
	1	2	3	4	5	6
Cement	25	25	25	25	30	25
Limestone Dust	25	75	50			
Fly Ash	25		25	70		
Fine Sand	50	50				75
Calcium Chloride	*	*	*	*	*	
* As prescribed in Subsection 512.03.1						

It shall be the Contractor's responsibility to have the grout mixture in its final position within one hour after adding the mixing water.

512.03--Construction Requirements.

512.03.1--Weather Limitations. Pressure grouting shall not be performed when the subgrade contains an abnormal amount of moisture as evidenced by standing water on the pavement or in joints or cracks. The air temperature shall be above 40°F in the shade or 35°F and rising before starting any grout pumping operation.

The following temperature ranges shall control the quantity of calcium chloride to be included in the grout mixture:

ATMOSPHERIC TEMPERATURE	PERCENT CALCIUM CHLORIDE BY WEIGHT OF CEMENT
35 - 55°F	5
56 - 69°F	4
70 - 79°F	3
80 - 89°F	2
90°F and above	1

The quantity shall be as prescribed unless otherwise directed by the Engineer. Upon approval of the Engineer, the calcium chloride may be reduced in quantity or eliminated as required with the use of Class "C" fly ash. The calcium chloride shall be thoroughly pre-mixed in the mixing water.

512.03.2--Equipment. The equipment shall be that customarily used in pressure grouting of earthen embankments or mud-jacking of concrete pavement. It shall consist of no less than the following:

- (a) Air compressors of sufficient capacity for operating pneumatic equipment.
- (b) Pneumatic equipment with a drill size that is compatible with the size of

the pump discharge nozzle. The equipment shall be in satisfactory operating condition and operated in such a manner as to prevent unnecessary damage to the pavement.

- (c) Equipment for accurately measuring and proportioning by volume or weight the component materials of the grout.
- (d) A mixer capable of thoroughly mixing the grout in an approved manner. A batch type and concrete mixing trucks may be used for types 2 and 3 grout mixtures. A colloidal mixer must be used for Types 1, 4 and 5 grout mixtures.
- (e) A positive action pump capable of forcing grout into voids and cavities beneath the pavement. The pump shall be capable of producing a discharge pressure range of 50 to 200 pounds per square inch of the end of the discharge pipe. The pumping system shall be equipped with a pressure gauge so that any instantaneous change in pressure can be detected by the inspector.
- (f) A stop watch and flow cone conforming to the dimensions and other requirements set out in the Department's SOP for Mississippi Test Method: MT 56.
- (g) Testing equipment shall consist of a tandem axle truck with dual wheels and the rear axles shall be loaded to 50 kips evenly distributed. The measuring equipment shall consist of no less than two gauges mounted on a measuring device that is capable of detecting movement of 0.001 of an inch. A driver and sufficient personnel to assist in preliminary testing, when required by the contract, and stability testing.
- (h) Equipment to measure pavement lift shall consist of no less than four gauges mounted on a measuring device or devices that is capable of detecting movement on each side of a joint or crack and the adjoining shoulder simultaneously. The equipment shall make such measurements to 0.001 of an inch.

512.03.3--Testing.

512.03.3.1--General. When testing is required, it is intended to locate all pavement having a deflection exceeding 0.030 of an inch. Testing may begin as early as 4:00 A.M. and continue as long as the surface temperature of the pavement remains below 85°F.

512.03.3.2--Preliminary Testing by the Department. When the pavement has been tested and marked by the Department, preliminary testing will not be required by the Contractor.

512.03.3.3--Preliminary Testing by the Contractor. When the contract includes a unit bid price for testing and it has not been performed by the Department, all of the project or designated areas shall be tested by the Contractor. Testing shall be performed as follows:

One set of gauges will be positioned on each side of a joint or crack near the pavement edge. The gauges will be zeroed with no load on either side of the joint or crack. The test truck will then be moved into position and stopped with the center of the nearest test axle about one foot from the joint or crack and the outside test wheel about one foot from the pavement edge. The gauges will be read and the test truck will then be moved across the joint or crack to a similar position for a second reading of the gauges. This operation will be repeated for each joint or crack to be tested. The inspector will be responsible for reading the gauges and subsequent recording. All locations with movement of more than 0.030 of an inch will require pressure grouting.

When testing shoulders, gauge positioning and testing shall be the same as indicated above for roadway pavement. The Engineer may adjust the position of the gauges to meet field conditions.

512.03.3.4--Stability Testing. After the designated areas have been pressure grouted in accordance with these specifications, they shall be retested in accordance with Subsection 512.03.3.3 when the contract includes a unit bid price for testing.

Any undersealed pavement with movement of 0.030 of an inch or more shall be re-grouted and tested as directed.

Any pavement which continues to show movement in excess of that specified after two properly performed groutings may be accepted, or the slab may be removed and replaced as directed by the Engineer.

512.03.4--Drilling Holes. The hole pattern and pumping sequence shown on the plans shall be used, except when modified to use drilling holes made from previous undersealing work. The Contractor may alter the hole pattern with the Engineer's approval. However, only the actual number of holes drilled will be measured for payment.

The holes shall be of a size and shape that best provide a positive seal for the pumping nozzle. The holes shall be drilled to a depth of approximately eight inches below the bottom of the concrete for the initial undersealing unless the Engineer approves an alternate depth. The number, depth and location of holes for undersealing after the initial operation shall be approved by the Engineer.

When pressure grouting cracks located in the shoulders at the edge of the pavement, the holes in the shoulders shall be located as shown on the plans or as

directed by the Engineer. These holes are to be drilled below the treated base.

512.03.5--Cleaning Holes. Prior to pumping the grout, compressed air shall be used to remove debris and to help provide a passage for the grout.

512.03.6--Pumping the Grout. The nozzle of the discharge hose shall be secured in the hole in a manner that provides a seal adequate to maintain the grout pressure underneath the slab. The nozzle end shall not extend below the bottom of the concrete. Pumping will continue until a clear flow of grout protrudes from an adjacent hole, joint or crack, or until the pavement begins to lift. This procedure will be repeated in other holes until all voids are supposedly filled. Plugging of holes during grouting operations will not be permitted.

Additional evidence that grouting should cease is a rapid rise of the pavement, or a rise of the adjacent shoulder. A minimum lifting of the pavement will generally be required to move grout into the cavities and voids, however, the lifting shall not exceed 0.050 of an inch. Movement of the pavement and adjacent shoulder will be monitored by the Contractor with equipment as required by Subsection 512.03.2(h). Care shall be taken not to crack the pavement by differential lifting. During pumping, very close attention shall be given to the lift measuring device to prevent excessive pumping pressures.

Moderate to major pavement cracks or pavement broken during the pumping operation due to the Contractor's negligence will be repaired or removed and replaced at the Contractor's expense.

512.03.7--Clean Up and Opening to Traffic. Deposits of mud and/or grout on the pavement or shoulders shall be removed and the surface cleaned before traffic is permitted on the section. Other debris, bags, spillage, etc., shall be removed from the right-of-way each day.

Traffic shall not use the undersealed pavement for at least three hours after grouting. Grouting operations shall cease at least three hours before sundown or earlier as necessary to permit the grout to harden at least three hours.

512.03.8--Permanently Sealing Holes. When pavement is not to be overlaid all grout shall be removed from the holes to the bottom surface of the concrete pavement and filled with a stiff sand-cement mixture or an approved quick setting patching material. Filled holes that ravel out or become damaged shall be repaired. All holes from previous undersealing work that were used by the Contractor shall also be similarly repaired at no cost to the Department.

512.03.9--Stability Tests. The test shall not be conducted until the undersealed pavement has been open to traffic for at least twelve hours. These tests shall be conducted in accordance with Subsection 512.03.3.4. Based upon these test results the pavement will be accepted or designated for further undersealing or

replaced as directed by the Engineer.

512.04--Method of Measurement. Holes drilled at locations and to the depths shown on the plans or directed by the Engineer will be measured per each. Additional holes required for subsequent undersealing operations will be measured per each.

Portland Cement incorporated into the grout mixture will be measured by the pound.

Calcium chloride incorporated into the completed work in accordance with the provisions of the contract will be measured by the pound.

When required, preliminary testing in accordance with Subsection 512.03.3.3 will be measured by the mile, linear horizontal measure, for each lane of roadway.

Stability testing at each joint or crack in accordance with Subsection 512.03.3.4 will be measured per each lane joint or each lane crack, up to a maximum of three tests.

512.05--Basis of Payment. Holes will be paid for at the contract unit price per each, which price shall be full compensation for drilling and sealing the hole.

The portland cement and calcium chloride incorporated into the grout mixture will be paid for at the contract unit price per pound, which price shall be full compensation for furnishing materials to be incorporated into the specified type of grout mixture, for all hauling, mixing, pumping and clean-up required to stabilize the pavement.

Preliminary testing will be paid for at the contract unit price per mile, which price shall be full compensation for furnishing all testing equipment, the load test truck and necessary personnel to assist in the testing.

Stability testing will be paid for at the contract unit price per each test and shall be full compensation for furnishing all testing equipment, the load test truck and necessary personnel to assist in the testing.

Cost for maintenance of traffic and individual traffic control devices as required by the Department's Traffic Control Plan shall be included in the unit prices for pressure grouting and will not be measured for separate payment under the provisions of Sections 618 and 619.

Payment will be made under:

512-A: Holes * - per each

Section 512

512-B: Portland Cement Pressure Grout Slurry, Type _____

512-C: Calcium Chloride

512-D: Preliminary Testing

512-E: Stability Testing, Lane Joint

512-F: Stability Testing, Lane Crack

* Indicate "In Shoulders" when holes are required in shoulders

Section 512

- per pound

- per pound

- per mile

- per each

- per each

DIVISION 600 - INCIDENTAL CONSTRUCTION**SECTION 601 - STRUCTURAL CONCRETE**

601.01--Description. This work consists of furnishing and placing portland cement concrete for specified structures in accordance with these specifications and in reasonably close conformity with the lines, grades, and dimensions shown on the plans or established by the Engineer.

Structural concrete will be divided into two groups. One group will be designated as Structural Concrete. The other group will be designated as Structural Concrete, Minor Structures. Unless otherwise specified in the contract, Structural Concrete, Minor Structures, will include inlets, catch basins, junction boxes, pipe headwalls, and pipe collars, regardless of the concrete quantity required for each of these structures; and other small structures containing less than 3.00 cubic yards of concrete each.

601.02--Materials.

601.02.1--General. Materials for structural concrete and their use, care, and handling shall be in accordance with Subsection 804.02. In addition, Type IP portland cement meeting the requirements of Subsection 701.04 will be permitted. Sampling and testing will be in accordance with Subsection 804.02.3.

601.02.2--Classification of Concrete. Concrete for this work shall be the class specified on the plans or in the bid schedule of the contract. Classes of concrete are identified in Subsection 804.02.6.

601.02.3--Precast Units. Design standards normally contemplate that structural concrete will be cast in place. However, the Contractor may request approval from the Engineer to furnish and install precast units in lieu of cast-in-place units. The request shall be accompanied by detailed drawings of the precast units and design data certified by a registered Professional Engineer as to structural and functional adequacy.

The foundation for precast units shall be carefully shaped to the precise contour and grade of the bottom of the unit before the unit is placed.

Precast units which are to be joined to other units shall be designed and manufactured with proper and adequate joints. Joints shall be sealed with a joint material meeting the applicable requirements of Section 707.

No additional payment will be allowed for precast units approved for use. Pay items and quantities will be as in cast in place in accordance with design standards.

601.03--Construction Requirements.

601.03.1--Composition of Concrete. The composition of the concrete shall be in accordance with Subsection 804.02.7.

601.03.2--Batching. Measuring and batching of component materials shall be in accordance with the applicable provisions of Section 804.

601.03.3--Mixing and Conveying Concrete. Concrete shall be mixed and conveyed in accordance with the applicable provisions of Subsection 804.03.2.

601.03.4--Cold or Hot Weather Concreting. Requirements for placement, protection, and curing of concrete during cold or hot weather are stipulated in Subsection 804.03.16.

601.03.5--Consistency. The slump of the concrete, determined in accordance with the provisions of Subsection 700.03, shall conform to the applicable requirements of Section 804.

601.03.6--Falsework and Forms.

601.03.6.1--Falsework. Falsework shall be in accordance with the applicable provisions of Subsection 804.03.13.

601.03.6.2--Forms. Forms shall conform to the requirements of Subsection 804.03.14.

601.03.6.3--Removal of Falsework, Forms, and Housing. The removal of falsework, forms, and the discontinuance of heating, shall be in accordance with the provisions and requirements of Subsection 804.03.15, except that the concrete shall conform to the following age or cylinder strength requirements:

	Column A	Column B
Wingwall and Wall Forms not Under Stress	24 to 48 hours*, minimum	1,000 psi
Wall Forms under Stress	7 days, minimum	2,200 psi
Backfill and Cover clear	3 days per foot clear span or clear height, whichever is the greater; or 10 days, minimum	2,400 psi

* As directed by the Engineer

If Type IP cement or Type I or II portland cement plus fly ash is used, only

Column B will be applicable.

When the walls and top slab of box culverts and box bridges are not to be poured monolithically, extreme care shall be used when forming and pouring the top slab on walls in which the concrete has not attained its full design strength. In order to prevent damage to fresh concrete, either of the following methods of forming and pouring may be used:

- (a) Subject to approval by the Engineer, the wall forms and deck forms may be so constructed and separately supported and braced that the walls may be poured and the wall forms removed as for wall forms not under stress. The Engineer may require a detailed plan of the proposed method of forming for approval. When this method of forming is used, the deck forms shall be in place and adequately and independently supported throughout before pouring the walls. Deck forms shall overlay the top edge and be flush with the face of the inside wall forms, but shall not be dependent upon any part of the inside wall forms for support. The intersection of the wall and deck forms shall be mortar tight. The wall forms may be constructed slightly less than the specified inside clear height of the structure and wedged upward from the bottom of the riser wall to permit easier removal. When this method is used, the concrete in the wall shall be poured flush with the top of the deck form.
- (b) At the option of the Contractor, the walls may be formed, adequately braced, and poured before the deck forms are in place. In this case the forms may be removed as for walls not under stress. Before erecting any part of the forming for the top slab, the concrete in the walls shall have attained the age or the strength specified for the removal of wall forms under stress.
- (c) The Contractor may elect to form and adequately support and brace the wall and deck forms as a composite unit before pouring the walls. In this case the outside forms may be removed as indicated for wall forms not under stress provided adequate provisions are made for forming the outer (vertical) surfaces for the subsequent deck pour. The inside wall forms shall remain in place as indicated for wall forms under stress.

601.03.6.4--Damage to Previously Placed Concrete. In the event previously placed concrete is damaged, all work on the affected structure shall cease immediately for an engineering assessment of the damage and the corrective work to be performed. No additional work shall be performed until this determination has been made, and the Engineer has given the Contractor approval to proceed with the corrective work and subsequent construction. All corrective work required shall be performed by the Contractor at no additional cost to the State.

601.03.7--Foundations and Footings. Foundations for structures shall be prepared in accordance with the requirements and provisions of Section 206.

All footings shall be poured "dry." Where footings can be placed in the "dry" without the use of cribs or cofferdams, the Engineer may permit back forms to be omitted, and concrete poured against the faces of the excavation.

601.03.8--Placing Reinforcing Steel. Reinforcing steel shall be placed in accordance with the requirements of Section 602 and as shown on the plans.

601.03.9--Handling and Placing Concrete. Handling and placing concrete shall be in accordance with the provisions of Subsection 804.03.6.

601.03.10--Expansion and Fixed Joints. All expansion and fixed joints shall conform to the applicable provisions of Subsection 804.03.18.

601.03.11--Finishing Concrete Surfaces. Unless otherwise authorized, the surface of the concrete shall be finished immediately after form removal.

Surface finishes shall conform to the applicable provisions of Subsection 804.03.19.

601.03.12--Curing Concrete. Concrete shall be cured in accordance with the provisions of Subsection 804.03.17.

601.04--Method of Measurement. Accepted quantities of structural concrete will be measured by the cubic yard. Except for changes ordered in writing by the Engineer, the neat dimensions shown on the plans will be used for computing volumes. The quantity of concrete in fillets, scorings, and chamfers one square inch or less in cross sectional area will be neglected in measurements.

No deductions will be made for the volume of concrete displaced by reinforcement, pipe or other conduits less than eight inches in nominal diameter, pipe posts, structural steel posts, or joint material.

When both Pay Item Numbers 601-A and 601-B are included in the contract, measurement of concrete for Pay Item No. 601-B will be limited to inlets, catch basins, junction boxes, pipe headwalls, and pipe collars, regardless of the concrete quantity required for each of these structures; and other small structures containing less than 3.00 cubic yards of concrete each.

601.05--Basis of Payment. Structural concrete will be paid for at the contract unit price per cubic yard which shall be full compensation for completing the work.

Payment will be made under:

601-A: Class ____ Structural Concrete

- per cubic yard

601-B: Class ____ Structural Concrete, Minor Structures

- per cubic yard

SECTION 602 - REINFORCING STEEL

602.01--Description. This work consists of furnishing and placing reinforcing steel in accordance with these specifications and in reasonably close conformity with the dimensions, bending, spacing, and other requirements shown on the plans.

602.02--Materials. Reinforcing steel shall conform to the requirements of Section 711 and Subsection 805.02.

602.03--Construction Requirements.

602.03.1--Bar List and Order Lists. The bar lists and bending schedules shown on the plans are primarily for the purpose of estimating quantities. Lengths of box culverts and box bridges, and depths of inlets, etc. shown on the plans are also approximate. The Contractor shall verify the quantity, size, and shape of the reinforcement for compliance with the structural drawings and make the necessary corrections, if any, before ordering. In the case of box culverts, box bridges, inlets, etc., verification shall be made after the Engineer has furnished the Contractor with a list of the staked lengths or depths for structures. Errors in the bar list and bending schedule shall not be cause for adjustment of the contract unit price, and the Contractor shall be fully responsible for all expenses caused by the Contractor's failure to furnish the proper size, shape, length, and quantity of reinforcing steel required.

When stipulated in the contract, or at the option of the Contractor when not stipulated, order lists and bending diagrams shall be furnished to the Engineer for approval. In these cases no materials shall be ordered until the lists and bending diagrams have been approved. The approval of order lists and bending diagrams by the Engineer will in no way relieve the Contractor of the responsibility for the correctness of the lists and diagrams. All expense incident to the revision of materials furnished in accordance with such lists and diagrams to make them comply with the design drawings and lengths as staked by the Engineer shall be borne by the Contractor.

602.03.2--Protection of Materials. Steel reinforcement shall be protected in accordance with Subsection 805.03.1.

602.03.3--Bending. Bending shall be in accordance with Subsection 805.03.2.

602.03.4--Placing and Fastening. The steel reinforcement shall be accurately

placed in the positions shown on the plans and firmly held during the placing and setting of concrete. Bars shall be tied at all intersections, except where spacing is less than one foot in each direction alternate intersections may be tied.

All reinforcing steel shall be securely spaced from the forms and between layers by means of approved precast mortar blocks of minimum size for adequacy, or metal spacers or devices.

Where possible, all spacer devices shall be arranged so that they cannot be detected in the completed structure. Metal devices which are in contact with the exterior surface of the concrete shall be one of the types specified in Subsection 711.02.7. Gravel, pieces of broken stone or brick, metal pipe, and wooden blocks shall not be used for spacers or chairs.

Reinforcement shall be accurately and securely placed to the dimensions shown on the plans, within a tolerance of one-half inch, then inspected and approved by the Engineer prior to the placing of concrete. Concrete placed in violation of this provision may be rejected and its removal required.

Substitution of different size bars will be permitted only with specific authorization by the Engineer. If steel is substituted, it shall have a cross sectional area equivalent to or greater than the design area.

602.03.4.1--Splicing. Except where shown on the plans, splicing of bars will not be permitted without the written approval of the Engineer. Splices, when permitted, shall be staggered as far apart as possible.

Unless otherwise shown on the plans, spliced bars shall be lapped 20 diameters. In lapped splices, the bars shall be placed in contact and wired together in a manner that will maintain the minimum clear distance specified between bars and to the surface of the concrete.

Welding of reinforcing steel will be permitted only if detailed on the plans or if authorized by the Engineer in writing. If welded, it shall conform to AWS Recommended Practices for Welding Reinforcing Steel, Metal Inserts, and Connections in Reinforced Concrete Construction.

602.03.4.2--Lapping of Mesh and Bar Mats. Sheets of mesh or bar mat reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall be at least one mesh in width.

602.04--Method of Measurement. Reinforcing steel will be measured in pounds based on the computed weight of the reinforcement shown on the plans or authorized. In cases where a structure is measured and paid for by the unit, complete in place, no measurement of reinforcing steel will be made.

The weight of plain or deformed bars and bar mats will be computed from the weights shown in the table of areas and weights in Subsection 711.02.1.

The weight for payment of steel fabric reinforcement will be computed from the theoretical weight of plain wire. If the weight per unit of area of the fabric is shown on the plans, that weight will be used for measurement.

The weight for payment of structural steel reinforcement will be the theoretical weight of the material used.

No allowance will be made for clips, wire, separators, wire chairs, and other material used in fastening the reinforcing in place. If bars are substituted upon the Contractor's request and as a result more steel is used than specified, only the quantity specified will be measured.

When splice laps, other than those shown on the plans, are made for the convenience of the Contractor, the extra steel will not be included in the measurement.

602.05--Basis of Payment. Reinforcing steel will be paid for at the contract unit price per pound which shall be full compensation for completing the work.

Payment will be made under:

602-A: Reinforcing Steel - per pound

SECTION 603 - CULVERTS AND STORM DRAINS

603.01--Description. This work consists of the construction or reconstruction of pipe culverts, precast box culverts, cattlepasses, storm drains, sewers, downspouts, special sections and headwalls, hereinafter referred to as "conduit," in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established. It shall also consist of furnishing all materials, except those specified to be furnished by the State, and joining the work to other conduit, catch basins, manholes, inlets, etc., as may be required to complete the work as designated.

This work shall also consist of constructing conduits for the encasement of underground utilities or for other use by the method of jacking or boring in accordance with these specifications and in reasonably close conformity with the lines and grades specified on the plans or established.

When alternate pipe is shown in the contract, the Contractor may select an alternate pipe from the alternate pipe group (type) shown in the plans or contract documents. The type of pipe used for alternate pipe shall meet the material

requirements of Subsection 603.02 for the type of pipe selected.

603.02--Materials. Conduit shall conform to the design and dimensions shown on the plans, and materials shall meet the requirements specified in the following sections or subsections:

Bituminous coated corrugated aluminum pipe and pipe arches.....	709.11
Bituminous coated corrugated metal pipe and pipe arches	709.03
Bituminous coated paved invert corrugated aluminum pipe and pipe arches	709.12
Bituminous coated paved invert corrugated metal pipe and pipe arches	709.04
Bituminous plastic sealer for joints.....	707.05
Cast iron pipe	709.01
Concrete arch pipe end sections.....	708.04
Concrete for headwalls.....	601
Concrete pipe cattlepasses	708.03
Corrugated aluminum pipe and pipe arches.....	709.09
Corrugated metal pipe and pipe arches	709.02
Corrugated poly vinyl chloride (PVC) pipe.....	708.17
Corrugated polyethylene pipe.....	708.17
Elbows and branch connections for concrete pipe.....	708.23
Flexible plastic gaskets for joints.....	707.06
Joint mortar	707.03
Joints for sanitary sewers	603.03.4
Metal end sections, elbows, and branch connections.....	709.18
Non-reinforced concrete pipe.....	708.02.4
Polymer coated corrugated metal pipe and pipe arches	709.05
Precast box culverts	708.22
Reinforced concrete arch pipe.....	708.14
Reinforced concrete elliptical pipe	708.15
Reinforced concrete end sections.....	708.04
Reinforced concrete pipe	708.02.5
Reinforcing steel	602
Rubber type gaskets	707.04
Steel pipe.....	709.19

When material requirements provide for modifications of design, acceptable modified designs will be shown on the plans.

603.03--Construction Requirements.

603.03.1--Excavation. Except for conduit to be installed by jacking and boring, trenches shall be excavated in accordance with the requirements of Section 206 to a width sufficient to allow for proper jointing of the conduit and thorough compaction of the bedding and backfill material under and around the conduit. Where feasible, trench walls shall be vertical.

The completed trench bottom shall be firm for its full length and width. Where required, in the case of cross drains, the trench shall have the camber specified.

Where conduit is to be placed in embankment, the excavation shall be made after the embankment has been completed to the specified height above the flow line of the conduit. In all cases the height above flow line shall be at least one foot.

In the case of pipe to be jacked or bored, only the trench excavation and bedding as set out in Subsection 603.03.9 shall be performed.

603.03.2--Bedding. Except for conduit placed in a vertical position or jacked or bored, the conduit bedding shall conform to one of the classes specified. When no bedding class is specified the requirements for Class C bedding or Class C modified bedding, as applicable shall apply.

CLASS A bedding consists of a continuous concrete cradle conforming to plan details, and constructed on an approved foundation.

CLASS B bedding consists of bedding the conduit to a depth of at least 30 percent of the vertical outside dimension of the conduit. The thickness of bedding material beneath the pipe shall be at least four inches. The bedding material shall be sand or selected sandy soil, all of which passes a 3/8 inch sieve and not more than 10 percent of which passes a No. 200 sieve. The layer of bedding material shall be shaped to fit the conduit for at least 15 percent of its total height. Recesses in the trench bottom shall be shaped to accommodate the bell when bell and spigot type conduit is used.

CLASS C bedding consists of bedding the conduit to a depth of at least 10 percent of its total height. The bed shall be shaped to fit the conduit and shall have recesses shaped to receive the bell if bell and spigot type pipe is used.

CLASS C MODIFIED bedding consists of bedding corrugated conduit to a depth of at least 10 percent of its total height. A bedding blanket of approved silty loam, sandy loam, concrete sand, or other approved sand or sandy soil shall be roughly shaped to fit the bottom of the pipe. Minimum thickness before placing pipe shall be as follows:

- 1 inch for 1/2 inch deep corrugations
- 2 inches for 1 inch deep corrugations
- 3 inches for 2 inches or 2 1/2 inches corrugations

For structural plate pipe the length of bedding arc need not exceed the width of the bottom plate.

Bedding for precast concrete box culverts shall consist of at least two inches of

Class 9, Group C, or better, granular material placed between graded forms set at least one foot outside each outside wall of the box culvert. The granular material shall be shaped to fit the bottom of the precast box culvert sections by screeding off the graded forms. After placement of the precast box culvert sections on the graded bedding, the forms may be removed and reused.

603.03.3--Laying Conduit. The conduit laying shall begin at the staked location of the downstream end of the conduit line. The lower segment of the conduit shall be in contact with the shaped bedding throughout its full length. Bell or groove ends of rigid conduits and outside circumferential laps of flexible conduits shall be placed facing upstream. Flexible conduits shall be placed with longitudinal laps or seams at the sides. Transverse joints for all types of coated flexible conduits shall maintain pipe alignment during construction and prevent infiltration of backfill material during the life of the structure.

Paved or partially lined conduit shall be laid so that the longitudinal center line of the paved segment coincides with the flow line. Elliptical and elliptically reinforced conduits shall be placed with the major axis within five degrees of a horizontal plane through the longitudinal axis of the conduit.

Construction requirements for end sections shall conform to the requirements for placing the pipe to which they are joined.

At the Contractor's option, subject to the written approval of the Engineer, concrete headwalls conforming to the Department's Standard Drawings may be substituted for premanufactured end sections without change in compensation.

603.03.4--Joining Conduit.

603.03.4.1--Storm Drainage. Rigid conduits may be either bell and spigot or tongue and groove design unless one type is specified. The method of joining conduit sections shall be such that the ends are fully entered, and the inner surfaces are reasonably flush and even. Unless otherwise specified, joints shall be sealed with rubber type gaskets, bituminous plastic sealer, or flexible plastic gaskets.

Joints for precast concrete box culverts shall be made with bituminous plastic sealer.

Rubber type gaskets shall be installed so as to form a flexible watertight seal.

For joints to be sealed with bituminous plastic, the joining ends shall be wiped clean and dry. The plastic compound shall be applied cold to the entire surface of tongues and grooves, the entire surface of bells and spigots, and the entire area of metal pipes to be covered by connecting bands. Sections of concrete pipe shall be forced together, and sections of metal pipe banded together, with excess

compound extruding both inside and outside the pipe. Excess compound shall be removed from interior surfaces, and the exterior shall be finished reasonably flush. After pipe has been joined with bituminous plastic compound, suitable kraft or other approved paper shall be placed over the outside joints to avoid mixing of soil with the compound.

For joints to be sealed with flexible plastic gasket material, the pipe shall be installed in a dry trench. Joints shall be made in such a manner that a slight internal extrusion of the plastic gasket will occur for the full circumference when the sections of pipe are forced together. Installation shall be in accordance with these specifications and the manufacturer's instructions. Plastic gasket material shall be applied only to surfaces which are dry. A primer of the type recommended by the manufacturer of the plastic gasket shall be applied to the tongue and groove and to the end surfaces, and the surface to be primed shall be clean and dry when the primer is applied. During cold weather the joint surfaces and the gasket shall be lightly heated, without damage to the pipe or joint material, immediately prior to forcing the sections of pipe together. During hot weather the Contractor shall place kraft or other approved paper over the joints to avoid mixing soil with the plastic gasket material.

For joints constructed of either bituminous plastic sealer or flexible plastic material, special care shall be taken to provide an equal uniform joint between pipe sections and to prevent one section from supporting the other. Backfilling operations may follow immediately.

Flexible conduits shall be firmly joined by coupling bands. The ends of flexible conduits fabricated with helical corrugations shall be adapted by reforming and/or modification for circumferential corrugated coupling bands. The width and thickness of corrugated bands for both circumferential and helical corrugated flexible conduits shall be in accordance with AASHTO Designation: M 36 except that the bands shall be no less than 10½ inches in width.

In lieu of the preceding requirements and in addition to being supplied or recommended by the pipe manufacturer, coupling bands for joining corrugated polyethylene pipe shall be in accordance with AASHTO Designation: M 294 and shall meet or exceed the soil-tightness requirements of the AASHTO Standard Specifications for Highway Bridges, Section 26, paragraph 26.4.2.4 (e).

Corrugated polyethylene pipe may also be furnished with bell & spigot type joints with O-ring rubber gasket meeting ASTM Designation: F 477 placed on the spigot end. At least two (2) corrugations of the spigot end must insert into the bell end.

Joints and fittings for poly vinyl chloride (PVC) pipe shall meet the requirements of ASTM Designation: F 949.

603.03.4.2--Pipe With Gaskets. Unless otherwise specified, joints for pipe requiring gaskets shall conform to the following:

- (a) Pipes requiring gaskets shall be constructed to accommodate the gasket in accordance with the recommendations of the manufacturer of the gasket. Rubber gaskets shall comply with Subsection 707.04, and flexible plastic gaskets shall comply with Subsection 707.06.
- (b) In municipalities and other local governments having codes and specifications for joining sanitary sewer conduit, the local codes and specifications shall be applicable.
- (c) Depending upon the type of pipe specified and the joint to be used, the Contractor shall perform the joining in accordance with the recommendations of the manufacturer of the joint material to the extent that the line will be water proofed both from infiltration and exfiltration insofar as is practicable. Evidence of leakage shall be corrected immediately.
- (d) Evidence of leakage or suspected leakage may be cause for requiring the Contractor to perform testing to determine the leakage present. In the case of sanitary sewer lines, leakage exceeding the tolerance permitted under the local governing code, or in the absence of such code the tolerances permitted by the Mississippi Department of Environmental Quality, Office of Pollution Control, will not be allowed.

Leakage in excess of the tolerances permitted shall be corrected by reworking the line as necessary. Retesting may be required if deemed by the Engineer to be indicated. All testing shall be at no additional cost to the Department.

603.03.5--Relaid Pipe. These construction specifications shall equally apply to relaid conduits. In addition, conduit salvaged for relaying shall be cleaned of all foreign material prior to reinstallation. All pipe damaged through carelessness or negligence on the part of the Contractor shall be replaced by new pipe or approved pipe at no additional cost to the Department.

Pipe and end sections designated for removal and relaying shall be removed in accordance with the provisions of Subsection 202.03.4.

603.03.6--Field Strutting. Where required by the plans, the vertical diameter of round flexible pipe shall be uniformly increased five percent by means of jacks applied after the entire line of pipe has been installed on the bedding but before backfilling. The vertical elongation shall be uniformly maintained by means of sufficient sills and struts or by sufficient horizontal ties as specified. Only horizontal ties shall be used for paved invert pipe.

Ties and struts shall be removed after the embankment is completed and compacted.

603.03.7--Backfilling. Conduit shall be inspected before backfill is placed. Conduit found to be out of alignment, unduly settled, or damaged shall be taken up and relaid or replaced. After approval of conduit, it shall be backfilled with specified material in accordance with Subsection 203.03.8.6.

603.03.8--Imperfect Trench. Under this method, the embankment shall be completed to a height above the conduit equal to the vertical outside diameter of the conduit plus one foot. A trench equal in width to the outside horizontal diameter of the conduit shall then be excavated to within one foot of the top of the conduit with the trench walls being as nearly vertical as possible. This trench shall be loosely filled with highly compactable soil. Straw, hay, corn stalks, leaves, brush, or sawdust may be used to fill the lower one-fourth to one-third of the trench. Construction of the remainder of the embankment shall then proceed in a normal manner.

603.03.9--Pipes and Encasements Jacked or Bored. No pipe shall be placed by jacking or boring unless so designated in the contract.

When jacking or boring is designated, the area of placement shall be carefully investigated so as not to interfere with existing underground utilities. Care shall also be taken to keep the disturbed area of construction to a minimum.

The line and grade and the limits, if any, of placement to be made by conventional open trench methods for each line of pipe will be established as provided in Subsection 105.08. Unless otherwise shown on the plans, sections of steel pipe shall be joined by welding for the full circumference of the pipe to form a continuous, rigid, watertight structure of the required length. Welding shall be performed in accordance with Subsection 810.03.5.

603.03.9.1--Jacking. The designated strength of the pipe to be jacked is determined for the final loading under the embankment. Additional reinforcement or strength of pipe required to withstand jacking pressure shall be the responsibility of the Contractor. Extra strength pipe furnished by the Contractor shall be at no additional cost to the Department.

Pipe larger than a 3½-inch ID shall not be pushed or jacked without boring or otherwise removing the soil as the pipe is advanced.

When required, suitable pits or trenches shall be excavated for the jacking operation and for placing the end joints of pipe. Where necessary, they shall be securely sheeted and braced to prevent caving.

Where pipe is required to be installed under railroads, highways, streets or other

facilities by jacking or boring methods, construction shall be done in a manner that will not interfere with the operation of the facility or weaken the roadbed or structure.

Jacks for forcing the pipe through the roadbed shall have a jacking head constructed in such a manner as to apply uniform pressure around the ring of the pipe. The pipe to be jacked shall be set on guides braced together to properly support the section of the pipe and direct it to the proper line and grade. In general, roadbed material shall be excavated just ahead of the pipe, the excavated material removed through the pipe, and the pipe then forced through the roadbed into the excavated space.

When requested, the Contractor shall furnish for the Engineer's approval a plan showing proposed method of handling. The plan shall include the design for the jacking head, and show the jacking support or back stop, arrangement and position of jacks, pipe guides, etc. complete in assembled position. The approval of this plan by the Engineer will not relieve the Contractor from the responsibility of obtaining the specified results.

The diameter of the excavation shall conform to the outside circumference of the pipe as closely as practicable. Voids which develop during the installation operation and which are determined by the Engineer to be detrimental to the work shall be pressure grouted with an approved mix.

The distance that the excavation extends beyond the end of the pipe will depend upon the character of the excavated material, but shall not exceed two feet in any case. This distance shall be decreased on instructions from the Engineer if the character of the material being excavated makes it desirable.

The pipe shall be jacked from the low or downstream end. Variation in the final position of the pipe from the line and grade established will be permitted only to the extent of two percent in lateral alignment and one percent in vertical grade, provided that the final grade of flow line is in the direction designated.

The Contractor may use a cutting edge around the head end which extends a short distance beyond the pipe end and has inside angles or lugs to keep the cutting edge from slipping back into the pipe.

When jacking of pipe is once begun, the operation shall be carried on without interruption, insofar as practicable, to prevent the pipe from becoming firmly set in the embankment.

All pipe damaged in jacking operations shall be removed and replaced by the Contractor at no additional cost to the State.

Pits or trenches excavated to facilitate jacking operations shall be backfilled

immediately after the jacking has been completed.

603.03.9.2--Boring. The boring shall proceed from a pit provided for the boring equipment and workmen. Excavation for pits and installation of shoring shall be as outlined under jacking. The location of the pit shall meet the approval of the Engineer. The holes are to be bored mechanically. The boring shall be done using a pilot hole. By this method an approximate two-inch pilot hole shall be bored the entire length of the crossing and shall be checked for line and grade on the opposite end of the bore from the work pit. This pilot hole, when approved, shall serve as the centerline of the larger diameter hole to be bored. Excavated material shall be placed near the top of the working pit and disposed of as required. The use of water or other fluids in connection with the boring operation will be permitted only to the extent to lubricate cuttings as provided herein. Jetting will not be permitted.

In unconsolidated soil formations, a gel-forming colloidal drilling fluid consisting of at least 10 percent of high grade carefully processed bentonite may be used to consolidate cuttings of the bit, seal the walls of the hole, and furnish lubrication for subsequent removal of cuttings and installation of the pipe immediately thereafter.

Allowable variation from line and grade shall be as specified under jacking. Precise measures are to be taken to prevent overcutting. Overcutting in excess of one-half inch shall be remedied by pressure grouting.

603.03.9.3--Grouting, Backfilling, and Cleanup. After the jacked conduit is in place, all joints in concrete pipe shall be cleaned carefully and pointed from the inside to afford a smooth continuous interior surface.

Extension of the line beyond that required to be jacked or bored shall be by conventional methods as set out in this section.

As soon after jacking as possible, the interstices around the outside of the pipe shall be filled by pressure grouting. The grout mixture shall consist of fine sand or silt, Type I cement of not less than 15 percent by volume, and water. The grout shall be placed through holes bored at such intervals that the grout can be determined as rising in an adjacent hole at least six inches above the top of the pipe. The water content of the grout shall be the minimum necessary to provide proper placement. Grouting shall be performed by qualified personnel with equipment especially designed for the purpose.

At the end of each day's grouting operation, or at the completion of the grouting operation for each line of pipe, whichever occurs first, the conduit shall be carefully inspected on the inside and all grout which has penetrated the pipe shall be removed and the inside surface wiped clean. Other waste grout which will impair the work shall be removed and disposed of.

After successive operations are completed, all sheeting, shoring, etc. shall be removed, excavations backfilled to the surface of the existing ground or as directed., the backfill compacted in accordance with the specifications, and all surplus material disposed of to the satisfaction of the Engineer.

603.04--Method of Measurement. The lengths of pipe and precast box culverts will be measured by the linear foot by multiplying the number of commercial lengths installed by the nominal length per section; except, portions of commercial lengths extending more than four feet beyond the ends of conduit actually required or at the face of structures will not be measured for payment.

Unless otherwise indicated on the plans, sections of lines of conduits placed by conventional methods will not be measured as pipe jacked or bored.

End sections, headwalls, elbows, branch connections, and other appurtenances for which pay items are listed will be measured by the number of units of the kind and size specified.

Pipe removed and relaid will be measured by the linear foot. End sections removed and relaid will be measured by the unit.

Excavation for conventionally installed conduits will be measured and paid for as set out in Section 206. Excavation for conduits placed by jacking or boring will not be measured for separate payment.

Excavation for precast box culverts will be measured in cubic yards as set out in Section 206 for cast-in-place box culverts of comparable sizes.

603.05--Basis of Payment. Accepted quantities of pipe and precast box culverts will be paid for at the contract unit price per linear foot.

End sections, headwalls, elbows, branch connections, and other appurtenances for which pay items are listed in the contract will be paid for at the contract unit price per each.

Pipe removed and relaid will be paid for at the contract unit price per linear foot. End sections removed and relaid will be paid for at the contract unit price per each.

The prices thus paid shall be full compensation for completing the work. Materials or work for which a pay item is not included and are necessary to complete the work under this section shall be furnished or performed and shall be considered incidental to the completed construction.

Payment will be made under:

FERROUS METAL CONDUIT

603-A: ____ " Steel Pipe, Wall Thickness ____ - per linear foot

603-B: ____ " Cast Iron Pipe, Class ____, Description - per linear foot

ALTERNATE CONDUIT

603-ALT: ____ " Type ____ Alternate Pipe - per linear foot

CONCRETE CONDUIT

603-CA: ____ " Reinforced Concrete Pipe, Class ____ - per linear foot

603-CB: ____ " Reinforced Concrete End Section - per each

603-CC: ____ " Non-Reinforced Concrete Pipe, Class ____ - per linear foot

603-CD: 48" x 72" Concrete Pipe Cattlepass - per linear foot

603-CE: ____ " x ____ " Concrete Arch Pipe, Class ____ - per linear foot

603-CF: ____ " x ____ " Concrete Arch Pipe End Section - per each

For conduit required to be jacked or bored, the appropriate pay item listed above will contain the term "Jacked" or "Bored", as applicable.

For conduit required to have rubber type or flexible type gasket, the appropriate pay item listed above will contain the term "Rubber Type Gasket" or "Flexible Type Gasket", as applicable.

CORRUGATED FERROUS METAL CONDUIT

603-MA: ____ " * Coated Corrugated Metal Pipe, ____ Gage,
____ Corrugation - per linear foot

603-MB: ____ " * Coated Corrugated Metal End Section,
____ Gage - per each

603-MC: ____ " x ____ " * Coated Corrugated Metal Arch Pipe,
____ Gage, ____ Corrugation - per linear foot

603-MD: ____ " x ____ " * Coated Corrugated Metal End
Section, ____ Gage - per each

603-ME: ____ " * Coated Paved Invert Corrugated Metal
Pipe, ____ Gage, ____ Corrugation - per linear foot

603-MF: ____ " * Coated Paved Invert Corrugated Metal End
Section, ____ Gage - per each

603-MG: ____ " x ____ " * Coated Paved Invert Corrugated Metal
Arch Pipe, ____ Gage, ____ Corrugation - per linear foot

603-MH: ____ " x ____ " * Coated Paved Invert Corrugated Metal
End Section, ____ Gage - per each

* Type Coating to be shown as either Zinc, Aluminum, Polymeric or Bituminous.

NOTE: The gage of pipe specified for various coating types will vary according to the Department's design policy.

CORRUGATED NON-FERROUS METAL CONDUIT

603-NA: ____ " Corrugated Aluminum Pipe, ____ Gage,
____ Corrugation - per linear foot

603-NB: ____ " Corrugated Aluminum End Section, ____ Gage - per each

603-NC: ____ " x ____ " Corrugated Aluminum Arch Pipe,
____ Gage, ____ Corrugation - per linear foot

603-ND: ____ " x ____ " Corrugated Aluminum End Section,
____ Gage - per each

603-NE: ____ " Bituminous Coated Corrugated Aluminum Pipe,
____ Gage - per linear foot

603-NF: ____ " Bituminous Coated Corrugated Aluminum End
Section, ____ Gage - per each

603-NG: ____ " x ____ " Bituminous Coated Corrugated Aluminum
Arch Pipe, ____ Gage, ____ Corrugation - per linear foot

603-NH: ____ " x ____ " Bituminous Coated Corrugated Aluminum
End Section, ____ Gage - per each

603-NI: ____ " Bituminous Coated Paved Invert Corrugated
Aluminum Pipe, ____ Gage, ____ Corrugation - per linear foot

603-NJ: ____ " Bituminous Coated Paved Invert Corrugated
Aluminum End Section, ____ Gage - per each

603-NK: ____" x ____" Bituminous Coated Paved Invert Corrugated
Aluminum Arch Pipe, ____ Gage, ____ Corrugation - per linear foot

603-NL: ____" x ____" Bituminous Coated Paved Invert Corrugated
Aluminum End Section, ____ Gage - per each

CORRUGATED POLYETHYLENE CONDUIT

603-PE: ____" Corrugated Polyethylene Pipe - per linear foot

CORRUGATED POLY VINYL CHLORIDE CONDUIT

603-PVC: ____" Corrugated Poly Vinyl Chloride Pipe - per linear foot

PRECAST BOX CULVERTS

603-PA: ____' x ____' Precast Concrete Box Culvert - per linear foot

603-PB: ____' x ____' Precast Concrete Box Culvert End Section - per each

RELAID PIPE

603-RA: ____" Pipe Removed and Relaid - per linear foot

603-RB: ____" End Section Removed and Relaid - per each

SPECIALS AND CONCRETE HEADWALLS

603-SA: Size & Angle Elbow, Materials per Pay Item No. ____ - per each

603-SB: Size Branch Connection Type & Description - per each

603-SC: Size & Type Headwall, Per Plans - per each

SECTION 604 - MANHOLES, INLETS AND CATCH BASINS

604.01--Description. This work consists of the construction of manholes, inlets, and catch basins in accordance with these specifications and in reasonably close conformity with the details, lines, grades, and dimensions shown on the plans or established by the Engineer.

Precast sectional manholes shall consist of furnishing and assembling precast sections for manholes, together with necessary fittings, bases, and connections, all constructed in accordance with these specifications and in reasonably close conformity with the details, lines, grades and dimensions shown on the plans, or established.

604.02--Materials. The materials used in this construction shall meet the requirements specified in the following Section or Subsections:

Masonry Brick, Grade SM	706.01
Mortar	714.11
Concrete	601
Reinforcing Steel	711.00 and 711.01
Gray Iron Castings	716.04
Bar Gratings	716.14

All bars, anchors, frames, hangers, etc. for castings and plates shall be approved prior to installation.

Inlet and outlet pipes shall be of the type, class and size indicated on the plans and shall conform to the requirements as set out in Section 603 for the particular type, class, and size of pipe specified.

Precast units will be considered for use under the provisions of Subsection 601.02.3. Precast (sectional) manholes shall conform to the requirements of AASHTO Designation: M 199.

604.03--Construction Requirements.

604.03.1--Brick Masonry. Brick masonry shall be constructed in conformity with the details shown on the plans and in accordance with the provisions of Section 611.

Where irons or other fittings enter the brick work, they shall be placed as the work is laid up, thoroughly bonded, accurately spaced, and lined. Upon completion of the masonry and setting of castings and fittings, the inside and outside surfaces of the masonry shall be neatly plastered with mortar 1/2 inch thick. Plastering shall have a uniform, smooth finish and shall be neatly pointed to all fittings.

604.03.2--Concrete Masonry. Unless otherwise specified, concrete masonry shall be constructed of Class "B" concrete in accordance with the requirements of Section 601.

604.03.3--Reinforcement. Reinforcement shall be placed as indicated on the plans or as directed and in accordance with the provisions of Section 602.

604.03.4--Optional Construction. When plan standards indicate portions of the structure may be constructed of either brick masonry or concrete, the Contractor may use either concrete or brick masonry for these portions, provided the plan dimensions for wall thickness, etc. are maintained. In either case the masonry, whether concrete or brick, will be measured for payment as stipulated in Subsection 604.04.

604.03.5--Inlet and Outlet Pipes. Unless otherwise directed, inlet and outlet pipes shall extend through the walls of manholes and catch basins for a sufficient distance beyond the outside surface to allow for connections and shall be cut flush with the wall on the inside surface and neatly pointed.

The concrete, or brick and mortar, shall be constructed around the pipes so as to prevent leakage and to form a neat connection.

604.03.6--Castings, Gratings, and Fittings. All castings and gratings shall be carefully handled. Injurious cracks, chips, surface mars, etc. which render them unsuitable for use or unsightly after being placed will be cause for rejection.

The castings, gratings, and fittings shall be placed as indicated on the plans or as directed to line and grade and in such a manner that subsequent adjustments will not be necessary.

When castings or gratings are to be set in concrete or cement mortar, all anchors or bolts shall be in the correct place and position before the concrete or mortar is placed, and they shall not be disturbed while the concrete or mortar is hardening.

Castings and gratings placed on previously constructed masonry shall be set in mortar beds or anchored to the masonry as shown on the plans or directed. The bearing surface of the original masonry shall present an even surface and conform to line and grade so that the entire face or back of the casting will come in contact with the masonry.

Castings and gratings shall be set firm and snug so that they will not rattle, shake, or move unnecessarily.

604.03.7--Precast Manholes. As trenches are opened for the pipe conduit, truly leveled bases shall be prepared at each manhole site. The bases may be cast-in-place or may consist of precast base units. In either case, the seated base shall be

truly horizontal. Inverts shall be smooth and accurately shaped to a semi-circular bottom conforming to the inside of the adjacent conduit, and extend upward at least half of the diameter of the conduit, or as shown on the plans. Joints shall be sealed in accordance with Section 603.

Steps in the manhole may be of cast-iron, aluminum, wrought iron, plastic or other material approved by the Engineer. All steps shall be built into the walls of precast sections in straight alignment to form a continuous ladder with a maximum distance of 16 inches between steps.

Each precast section shall have not more than two holes for handling. The holes shall be plugged with mortar after installation.

Concrete covers may be precast, or cast at the site. The covers shall be cast accurately to the dimensions and design indicated on the plans.

604.03.8--Excavation and Backfill. Excavation shall be performed as required for proper construction. Backfill shall be performed in accordance with the provisions of Subsection 203.03.8.6.

604.03.9--Cleaning Up. Upon completion, all structures shall be thoroughly cleaned of accumulations of silt, debris, and foreign matter. All surplus material shall be removed, and the site and the structure shall be maintained in a clean and neat condition until release of maintenance.

604.04--Method of Measurement. When either concrete masonry or brick masonry is permitted, and when concrete is specified, measurement will be by the cubic yard in accordance with 601.04 for Structural Concrete - Minor Structures.

Precast manholes will be measured per linear foot of depth from the flowline of the manhole to the top of the cover, or as indicated on the plans.

Reinforcing steel will be measured per pound in accordance with Subsection 602.04.

When brick masonry only is specified, measurement will be by the cubic yard or per thousand (M) brick in accordance with Subsection 611.04.

Excavation will not be measured for payment as a separate item. The cost of excavation shall be included in the unit price for concrete or brick masonry.

Castings, gratings and metallic manhole covers will be computed in pounds from the dimensions shown on the plans and based on the unit weights of metals set out in Section 810.

Fittings will not be measured for separate payment. Their cost shall be included in the price for concrete or brick masonry.

604.05--Basis of Payment. Structural concrete, reinforcing steel, and brick masonry will be paid for at the respective contract unit price in accordance with Subsections 601.05, 602.05, or 611.05 as applicable.

Precast Manholes will be paid for at the contract bid price per linear foot of depth, which price shall be full compensation for all necessary excavation, sheeting, cribbing, shoring, bracing, well-pointing, furnishing and assembling all elements of the manhole including concrete bases & covers except metallic cover and frame, for all other items of work necessary and incident to the complete construction and for all equipment, labor, tools and incidentals necessary to complete the work.

Castings and gratings will be paid for at the contract unit price per pound for castings or gratings, complete in place. These prices shall be full compensation for completing the work.

Payment will be made under:

- 604-A: Castings - per pound
- 604-B: Gratings - per pound
- 604-C: Precast Manhole, ____" Diameter - per linear foot

SECTION 605 - UNDERDRAINS

605.01--Description. This work consists of furnishing all materials and constructing pipe underdrains in accordance with these specifications and in reasonably close conformity with the lines and grades indicated on the plans or established by the Engineer; furnishing materials and constructing filter beds as specified; and furnishing and installing plastic pipe edge drains and edge drain outlets, vents and miscellaneous appurtenances as shown on the drawings in the plans, and as specified herein. This work also includes the video inspection and reporting of edge drain system installation.

605.02--Materials.

605.02.1--Drain Tile and Pipe. Drain tile and pipe shall be of the classes and sizes indicated and shall meet the requirements of the following Subsections:

- Bituminous Coated Corrugated Aluminum Alloy Pipe for Underdrains 709.13
- Bituminous Coated Corrugated Metal Pipe for Underdrains 709.07

Concrete Drain Tile 708.06

Corrugated Aluminum Pipe for Underdrains 709.10

Corrugated Metal Pipe for Underdrains 709.06

Corrugated Polyethylene Drainage Tubing 708.19

Geotextile 714.13

Perforated Concrete Pipe 708.05

Plastic Pipe for Underdrains 708.18

Polymer Coated Corrugated Metal Pipe for Underdrains 709.08

Porous Concrete Pipe 708.07

Semi-circular Perforated Plastic Pipe for Underdrains 708.20

605.02.2--Material for Bedding and Covering. Bedding and covering material shall conform to the requirements of Section 704. Unless otherwise specified, Type C shall be used.

605.02.3--Appurtenances. Appurtenances such as flush-out units, small animal guards, signs, etc. shall be as shown on the plans and shall be of new, good commercial quality materials approved by the Engineer.

605.02.4--Edge Drain Pipe and Fittings.

605.02.4.1--General. Pipe for edge drains and fittings shall be four-inch nominal size, and shall be either Schedule 40 or Schedule 80 polyvinyl chloride (PVC) plastic pipe conforming to the requirements of ASTM Designation: D 1785.

Fittings, except for "Y" fittings, shall be socket-type fittings conforming to the requirements of ASTM Designation: D 2467 for Schedule 80 pipe and ASTM Designation: D 2466 for Schedule 40 pipe.

The Contractor may elect to furnish one of the following perforated pipe in lieu of the pipe listed above. Regardless of the pipe used, it shall be four-inch nominal size.

- a) Pipe conforming to Subsection 708.18 of the Standard Specifications with SDR number ranging from 23.5 to 35 and having a minimum pipe stiffness value of 50 psi
- b) Corrugated polyethylene drainage tubing or corrugated high density polyethylene (HDPE) pipe conforming to the requirements of AASHTO Designation: M 252, Type SP with the stipulation that the minimum pipe stiffness value shall be 50 psi. The pipe and fittings shall be made of virgin polyethylene compounds which conform with the requirements of cell class 324420C as defined and described in ASTM Designation: D 3350, except that the carbon black content shall not exceed 5%. Compounds that have higher cell classifications in one or more

properties are acceptable provided product requirements are met.

Pipe used for the edge drain outlet/vents shall be either PVC or corrugated high density polyethylene (HDPE) pipe. PVC pipe shall meet the requirements of ASTM Designation: D 1785 as stated above, and HDPE pipe shall meet the requirements of AASHTO Designation: M 252 as stated above.

All "Y" fittings shall be smooth interior wall fittings fabricated from pipe conforming to the requirements of the edge drain outlet pipe. The fitting shall provide an unobstructed passageway through both legs of the "Y".

Edge drain outlet and vent covers shall consist of commercial quality 3 x 3 galvanized hardware cloth, 0.063-inch wire or equal. The outlet and vent covers shall be installed at the end of each outlet pipe and vent pipe.

The Contractor shall furnish to the Engineer three copies of the manufacturer's certified test reports and certification covering each shipment of pipe stating the amount furnished and that the pipe, fittings, couplings, etc. comply with the requirements of the specifications.

605.02.4.2--Untreated Permeable Material. The untreated permeable material used to backfill the edge drain pipe and outlet/vent trenches shall be Type 57 filter material and shall conform to the requirements of Subsection 703.03, Coarse Aggregate for Portland Cement Concrete, for Size 57 coarse aggregate. The type of aggregate may also be slag or granite. Mixing of different types of aggregate will not be permitted.

605.02.4.3--Filter Fabric. The filter geotextile used with edge drains and edge drain outlets shall be Type V geotextile meeting the requirements of Subsection 714.13.

605.02.4.4--Miscellaneous. Concrete for aprons shall be Class "C" concrete meeting the requirements of Subsection 804.02.10.

Mortar placed where edge drain outlets and vents connect to drainage pipes and existing drainage inlets shall conform to the provisions of Subsection 714.11.5, Masonry Mortar, except that the sand and cement shall be commercial quality.

605.03--Construction Requirements.

605.03.1--Pipe Installation.

605.03.1.1--Preparation of Trench. Trenches shall be excavated to the dimensions and grade shown on the plans or as directed. In the event the dimensions of the trench are not indicated on the plans, the trench shall be at least as wide as the outside diameter of the pipe plus eight inches on each side, and

shall be of sufficient depth to allow proper installation of the pipe and covering.

If bell and spigot pipe is used, recesses shall be cut to allow uniform bearing of the pipe on the bottom of the trench.

605.03.1.2--Pipe Laying.

605.03.1.2.1--General. Except where settlement occurs due to reasons beyond the control of the Contractor, the Contractor shall be responsible for the alignment and grade of pipe underdrains. Where settlement occurs due to improper excavation, bedding or backfill, negligence, or carelessness on the part of the Contractor, the pipe shall be taken up and properly relaid or replaced without extra compensation.

605.03.1.2.2--Drain Tile. Drain tile shall be firmly embedded on the bottom of the trench, conforming to line and grade, and with the ends approximately 1/4 inch apart. If, in the judgment of the Engineer, the soil is of a composition such that it will wash into the joints, the joints shall be wrapped with strips of tar paper approximately four inches wide. Bedding or cover material shall then be placed around the paper to prevent its displacement. No additional compensation will be allowed for this operation.

605.03.1.2.3--Bell and Spigot Type. Concrete pipe of the bell and spigot type shall be firmly embedded on the bottom of the trench, with the bell ends up grade, and shall have close fitting joints. No mortar will be required in the joints.

605.03.1.2.4--Perforated Pipe. Unless otherwise indicated on the plans, perforated pipe shall be laid with the perforated side down. Unless otherwise specified, perforated pipe shall be laid on a four-inch bed of approved filter material.

605.03.1.2.5--Corrugated Metal Pipe. Corrugated metal pipe shall be laid with the separate sections firmly joined together by connecting bands of an approved type.

605.03.1.2.6--Laterals. Laterals and other connections shall be made with suitable special sections.

605.03.1.2.7--Dead Ends. Dead ends of pipe underdrains shall be closed with a suitable plug of concrete placed over and around the end so as to hold the pipe securely in place.

605.03.1.2.8--Underdrain Outlets. When indicated on the plans non-perforated underdrain outlets shall be joined to the underdrains.

605.03.1.3--Appurtenances. Underdrain appurtenances such as flush-out units,

small animal guards, signs, etc. shall be constructed in accordance with the details shown on the plans and shall be of good quality workmanship.

605.03.1.4--Pipe Covering. After the pipe underdrain has been laid, it shall be covered immediately with the specified filter material to the dimensions shown on the plans. The remainder of the trench, if any, shall be filled with the specified material, placed in six-inch layers, and compacted to the specified density.

605.03.2--Blind Drains. Trenches for blind drains shall be excavated to the width and depth shown on the plans. The trench shall be filled with filter material to the depth required by the plans. The remaining upper portion of trench shall be filled with either granular or impervious material as specified. All filling material shall be thoroughly compacted, and if under the pavement structure the material shall be compacted to the density specified in the contract.

605.03.3--Combination Storm Drain and Underdrain. Where the plans indicate that a conduit is to serve as a combination storm drain and underdrain, the conduit shall in general be constructed in accordance with Section 603. Modifications of Section 603 to provide that the conduit also serve as an underdrain shall be performed under this section. Modifications shall be as shown on the plans.

The Contractor shall carefully grade and shape the compacted backfill for the lower portion of the pipe so that water entering the filter material will be adequately drained into the unsealed portion of the joints. In no case shall the surface of the compacted backfill be below the sealed portion of the joints. After the lower portion of the joint has been backfilled, compacted, and shaped as indicated above, filter material shall be placed for the full depth shown on the plans.

Each layer of filter material shall be compacted to the satisfaction of the Engineer.

Upon completion of the placement and compaction of the filter material, superimposed materials shall be placed immediately, or a temporary covering of approved material shall be placed and compacted in order to prevent unnecessary infiltration of loose material into the upper portion of the filter material. Should appreciable contamination occur because of failure to adequately protect the surface of the filter material, that portion of the work considered to be unsatisfactory shall be removed and replaced with satisfactory work at no additional cost to the Department.

If temporary materials used to protect the upper portion of the filter material do not meet the requirements for the superimposed course, the temporary materials shall be carefully removed to expose clean filter materials immediately prior to

placement of the required superimposed course.

605.03.4--Filter Beds. Excavation for filter beds shall be made to the elevation and dimensions indicated on the plans. The surface of the excavated area on which the filter bed is to be placed shall be smooth, firm, and well drained. Filter material of the types shown on the plans shall be placed, thoroughly compacted, and shaped to the dimensions indicated on the plans. Unless otherwise specified, compaction shall be to the satisfaction of the Engineer.

When impervious material or other materials are specified to be placed over the filter material, the compacted filter material shall be covered as soon as practicable with this material and compacted to the required design soil density in accordance with Section 203.

605.03.5--Edge Drain Installation. Edge drains, edge drain outlets, vents, untreated permeable material, and filter geotextile shall be installed in accordance with the details shown on the plans or in the contract documents, as specified herein and applicable Special Provisions. The vertical tolerance (height) for the trench shall be plus or minus one-half inch. The horizontal tolerance (width) shall be plus one inch.

Surfaces to receive filter fabric, immediately prior to placing, shall be free of loose or extraneous material and sharp objects that may damage the filter geotextile during installation.

The geotextile shall be stretched, aligned and placed in a wrinkle-free manner.

Adjacent rolls of the geotextile shall be overlapped from 12 to 18 inches. The preceding roll shall overlap the following roll in the direction the material is being spread.

Should the geotextile be damaged during placing, the torn or punctured section shall be either completely replaced or shall be repaired by placing a piece of geotextile that is large enough to cover the damaged area and to meet the overlap requirement.

Damage to the geotextile resulting from the Contractor's vehicles, equipment or operations shall be replaced or repaired by the Contractor at no additional cost to the State.

Pipe and fittings shall be joined by solvent cementing with commercial quality solvent cement and primer specifically manufactured for use with rigid PVC plastic pipe and fittings. The solvent cement and primer used shall be made by the same manufacturer. The color of the primer shall contrast with the color of the pipe and fittings. The solvent cement and primer shall be used in accordance with the manufacturer's printed instructions.

When corrugated polyethylene drainage tubing is used, joints shall be made with split couplings, corrugated to engage the pipe corrugations, and shall engage a minimum of four corrugations, two on each side of the pipe joint.

When poly vinyl chloride corrugated sewer pipe is used, joints shall be made in accordance with the pipe manufacturer's recommendations and ASTM Designation: F 949.

The backfill of the trench along the pavement edge, across the shoulder and outside the shoulder shall be as shown in the details of the drawings.

The Contractor may dispose of the trenched materials on the slopes provided all material passes a three-inch ring and blends into the existing or reconstructed roadway slopes. Otherwise, the material must be disposed of outside the right-of-way.

The edge drain and edge drain outlets and vents shall be clean at the time of installation and shall be free of obstructions after installation.

605.03.6--Edge Drain Inspection. The edge drain system shall be inspected by the Contractor after all roadway construction items are completed within a given section of roadway. A video record and written report for each line inspected shall be furnished to the Engineer. The line location (station number), distance traversed by the camera, and pipe deficiency shall be recorded on a standard VHS video tape and in a written report. As a minimum, fifty percent (50%) of the entire edge drain system shall be video inspected. Video inspection shall be performed in the presence of the Engineer or his/her representative.

Video equipment used for inspecting the edge drain system shall be capable of the following minimum requirements:

- (1) Providing color video inspection of pipelines for 4-inch inside diameter pipe in a wet, corrosive environment and negotiating a 90° bend in a smooth bore or corrugated pipe. The color camera must have a minimum 400-line horizontal resolution.
- (2) Video inspecting up to 300 linear feet of edge drain pipe, by pushing, pull cabling, jetting or tractoring the camera through the line and recording the condition on video tape.
- (3) Equipped with a video monitor capable of allowing live viewing of the video inspection.
- (4) Displaying and recording on the video tape, the date, line identification, footage and type of pipe deficiency.

- (5) Recording the distance traversed by the camera to within 0.5 feet, allowing for overlapping of distances if a reversal is required to permit full-length inspection.

A written report of the drain system inspection shall be completed on the MDOT Edge Drain and Edge Drain Outlet/Vent Inspection Form, or other form approved by the Engineer.

Any foreign materials that restricts the movement of the inspection equipment or impairs the quality of the video within the drain system shall be flushed from the system. Flushing of the drain system will be by water jetting or other methods approved by the Engineer. Costs associated with flushing the system will not be made under separate payment. The system shall be re-inspected after flushing in the same manner as the initial inspection as described above. Re-inspection of the system shall be at no additional cost to the State.

Any drain system pipe that can not be cleared from obstructions, damaged or does not conform to the lines and grades shown on the plans shall be replaced at no additional cost to the State.

605.04--Method of Measurement. Tile or pipe underdrains, including all special sections and connections, and blind drains will be measured from end to end by the linear foot along their center lines.

Appurtenances, specified as pay items, will be measured by the unit indicated. All necessary appurtenances not listed as pay items will not be measured for separate payment.

Excavation for pipe underdrains will be measured and paid for under the provisions of Section 206 for the widths shown on the plans. Excavation for blind drains and filter beds will be measured and paid for in accordance with the provisions of Section 203.

Measurement and payment for conduit required to be used as combination storm drain and underdrain will be made in accordance with Section 603, except for those features modified as provided in this section.

Measurement of filter materials used in the construction of underdrains, combination storm drains and underdrains, and filter beds will be made as follows:

- (a) In the case of underdrains and combination storm drains and underdrains, the measurement will be made complete-in-place and computed from plan dimensions. No deduction will be made for the volume occupied by pipe or portion of pipe for pipes eight inches and less in diameter. Deductions will be made for pipes larger than eight inches in diameter.

- (b) In the case of filter beds, the material of the required types will be measured by the cubic yard (LVM) or by the ton as indicated in the proposal, from which will be deducted all quantities determined by the Engineer to have been placed in excess of that necessary because of the failure of the Contractor to establish and maintain the grades, lines, slopes, and other dimensions in reasonably close conformity with those shown on the plans or established by the Engineer. In computing the volume of quantities to be deducted from LVM measurement, the Engineer will determine the excess by the best procedure deemed appropriate and convert the results to LVM as provided in Subsection 109.01.

When measurement by the ton is indicated on the plans and in the proposal, measurement will be based on the dry unit weight in accordance with Subsection 304.04.

Except when specifically indicated as a pay item, no measurement for payment will be made for filter material for blind drains.

When designated as a pay item in the contract, geotextile for subsurface drainage will be measured by the square yard based on plan dimensions.

Edge drains and edge drain outlets/vents, complete in place, will be measured by the linear foot along the line of the trench. On slopes the length to be paid for will be the slope length of the trench.

Edge drain inspection will be measured by the linear foot of edge drain and edge drain outlet/vent inspected. The length to be paid for will be the slope length of the trench.

The Class "C" Concrete for concrete edge drain aprons shall be measured by the cubic yard.

Wire mesh covers, pipe and pipe fittings, couplings, untreated permeable material, geotextile fabric, granular material, bituminous pavement mixture, trenching, disposal of trenched materials and other miscellaneous appurtenances used for edge drain installation will not be measured separately for payment.

605.05--Basis of Payment. Tile and pipe underdrains and blind drains will be paid for at the contract unit price per linear foot. Appurtenances listed as pay items will be paid for at the contract unit price for the units specified.

Filter material for underdrains and combination storm drains and underdrains will be paid for at the contract unit price per cubic yard (FM).

Filter material for filter beds will be paid for at the contract unit price per cubic yard (LVM) or ton.

Excavation for tile or pipe underdrains will be paid for in accordance with the provisions of Subsection 206.05. Excavation for blind drains will be paid for in accordance with the provisions of Subsection 203.05.

Geotextile for subsurface drainage will be paid for at the contract unit price per square yard.

Edge drain and edge drain outlets/vents will be paid for at the contract unit price per linear foot, which price shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all the work involved in constructing edge drains and edge drain outlets/vents complete in place, including wire mesh covers, pipe and pipe fittings, couplings, untreated permeable material, geotextile fabric, granular material, bituminous pavement mixture, trenching, disposal of trenched materials and other miscellaneous appurtenances as shown on the plans and as specified herein.

Edge drain inspection, completed and accepted, will be paid for at the contract unit price per linear foot of edge drain and edge drain outlet/vent inspected, which price shall be full compensation for furnishing all labor, equipment, VHS tapes, tools and incidentals necessary to complete the work.

Class "C" concrete for edge drain aprons as shown on the plans and as specified herein shall be paid for under Pay Item No. 221-A, Portland Cement Concrete Paved Ditch.

The prices thus paid shall be full compensation for completing the work.

Payment will be made under:

- 605-A: ____" Concrete Drain Tile for Underdrains, Class ____ - per linear foot
- 605-B: ____" Perforated Concrete Pipe for Underdrains,
Class ____ - per linear foot
- 605-C: ____" Porous Concrete Pipe for Underdrains - per linear foot
- 605-D: ____" Perforated Corrugated Metal Pipe for Underdrains,
Type ____ - per linear foot
- 605-E: ____" Non-perforated Corrugated Metal Pipe for
Underdrains, Type ____ - per linear foot

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605-F: ____" Bituminous Coated Perforated Corrugated Metal Pipe for Underdrains, Type____	- per linear foot
605-G: ____" Bituminous Coated Non-perforated Corrugated Metal Pipe for Underdrains, Type____	- per linear foot
605-H: Edge Drain	- per linear foot
605-I: Edge Drain Outlets/Vents	- per linear foot
605-J: Edge Drain & Edge Drain Outlet/Vent Inspection	- per linear foot
605-K: Blank	
605-L: Blank	
605-M: ____" Perforated Corrugated Aluminum Pipe for Underdrains, Type____	- per linear foot
605-N: ____" Non-perforated Corrugated Aluminum Pipe for Underdrains, Type ____	- per linear foot
605-O: ____" Perforated Sewer Pipe for Underdrains, SDR ____	- per linear foot
605-P: ____" Non-perforated Sewer Pipe for Underdrains, SDR ____	- per linear foot
605-Q: ____" Perforated Corrugated Polyethylene Drainage Tubing for Underdrains	- per linear foot
605-R: ____" Non-perforated Corrugated Polyethylene Drainage Tubing for Underdrains	- per linear foot
605-S: ____" Semi-circular Perforated Plastic Pipe for Underdrains	- per linear foot
605-T: ____" Perforated Pipe for Underdrains, Optional*	- per linear foot

* Meeting the requirements for Pay Item Numbers 605-B, Standard Strength; 605-D, Type III; 605-K, Type SJ or TJ; 605-M, Type III; 605-O, SDR 35, 41 or 42; 605-Q, or 605-S.

605-U: ____" Non-perforated Pipe for Underdrains, Optional** - per linear foot

** Meeting the requirements for Pay Item Numbers 605-E, Type III; 605-L, Type SJ or TJ; 605-N, Type III; 605-P, SDR 35, 41 or 42; or 605-R.

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605-V: ____ " Blind Drains	- per linear foot
605-W: Filter Material for Combination Storm Drain and/or Underdrains, Type ____	- per cubic yard
605-X: Filter Material for Filter Beds, Type ____	- per cubic yard or ton
605-Y: Impervious Material, Type ____	- per cubic yard or ton
605-Z: Underdrain Appurtenances, <u>Description</u>	- per lump sum, each, etc.
605-AA: Geotextile for Subsurface Drainage, Type <u>***</u> , AOS <u>***</u>	- per square yard

*** When not designated, see Subsection 714.13.

SECTION 606 - GUARD RAIL

606.01--Description. This work consists of furnishing and erecting complete sections of guard rail in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer. This work shall also include the installation of reflectors on guard rail posts and the installation of guard posts.

When the work requires the removal and replacement of guardrail on a facility opened to traffic, the materials necessary for replacement will be on hand before removal begins. The Contractor shall not begin work on any section of guardrail until preparations have been made to complete the installation of the section, including posts, rail, anchors, and hardware as a continuous operation. Once work has been initiated on a section, the work shall be prosecuted to its completion unless inclement weather or other conditions beyond the control of the Contractor interfere with the work. Uncompleted guardrail or special end sections shall not be left exposed to the travelling public without the approval of the Engineer. If approval is granted, the uncompleted section must satisfactorily be marked with drums, barricades, or other devices, as directed by the Engineer, at no additional cost to the Department. In no case will uncompleted guardrail or special end sections be allowed to remain over a weekend or holiday period.

606.02--Materials. Unless otherwise specified, all materials shall conform to the requirements shown on the plans and set forth in Section 712. Reflectors shall be of the type, size, and color designated on the plans and shall conform to the requirements of Subsections 721.07, or 721.08, as applicable.

When not designated, guard rail posts, meeting the requirements of Subsection 712.06, may be wood or steel but shall be of the same type for the entire project.

Posts for bridge end sections shall be of the same type as the guard rail line posts. Posts for cable anchorage sections may be wood or steel but shall be of the same type for the entire project.

Terminal end sections, installed as per manufacturer's recommendations, shall be National Cooperative Highway Research Program (NCHRP) Report 350 Test Level 3 (TL-3) approved.

The Contractor shall furnish the Project Engineer two (2) copies of the manufacturer's installation instructions prior to beginning guard rail operations.

606.03--Construction Requirements.

606.03.1--Erection of Guard Posts. Generally, guard post will be constructed of timber post. However, on some occasion guard post may be constructed of steel with special requirements detailed on special design sheets in the plans. The posts shall be set plumb and firm to the depth indicated and accurately lined, spaced, and graded. After the posts are in place, the holes shall be backfilled with suitable material which shall be thoroughly compacted in approximate six inch layers by tamping. Posts shall not be sawed or cut after treatment. If set posts are found to be in improper position with reference to alignment or grade, they shall be removed and reset properly, except that if found to be high they may be driven to the proper elevation provided the tops of the posts are protected by suitable driving caps.

Wood guard rail posts and guard posts may be erected by driving or by a combination of drilling and driving when after demonstration at the project site the Engineer approves the results as being equal to or better than the results that can be obtained by erecting posts in drilled holes and backfilling. Acceptability of driving or combined drilling-driving will be contingent on the following conditions:

- (a) Use of approved and proven mechanical driving equipment;
- (b) Maintenance of acceptable results without impairing the structural integrity of adjacent materials or structures;
- (c) Use of drills to penetrate courses that may resist penetration by driving. When drills of nominal post-size are used the void between the post and the edge of the hole shall be filled with Grade AC-13 asphalt. Holes larger than nominal post-size drilled through paved surfaces or cement treated courses shall be properly backfilled with hot or cold bituminous pavement;
- (d) Out-of-tolerance posts shall be pulled and properly replaced or reset, and all disrupted portions of the roadbed structure restored as directed; and

- (e) Mutilated posts shall be pulled and properly replaced, and all disrupted portions of the roadbed structure restored in kind or as directed.

Steel guard rail posts may be erected by driving, provided an approved driving head is used.

The top inside edges of posts shall be set within 1/4 inch of correct vertical and horizontal alignment.

Guard rail posts on bridges shall be plumb and accurately spaced and lined.

Where sections of rail are located on curves, the posts shall be erected so as to obtain the designated panel lengths measured along the face of the rail.

606.03.2--Anchorage. Anchors and braces shall be furnished and placed as shown on the plans.

606.03.3--Erection of Rails. All fabrication and forming of rail elements shall be completed prior to application of the shop paint. Field punching, cutting, burning, or welding will not be permitted, except where specifically authorized by the Engineer and subject to the conditions thereof.

The rail shall be erected in a manner resulting in a smooth, continuous, taut rail conforming to the line and grade shown on the plans or established. In the erection of rail, consideration shall be given to the prevailing temperature and the anticipated rise and fall of temperature ultimately affecting the length of the rail.

Where required, ends of rail shall be flared within the limits shown on the plans or established.

Bolts and clips used for fastening rails or fittings to posts shall be drawn up tightly, and all bolts, except "take up" device bolts, shall be of such length as to not project beyond the nut more than the limits shown on the plans. Sawing of ends of bolts to meet this requirements will be permitted.

606.03.4--Repairing Rails and Fittings. Where the galvanizing on guardrail or fittings has been damaged, the coating shall be repaired by re-galvanizing or the surface repaired by painting with two coats of zinc oxide paint approved by the Engineer.

606.03.5--Reflectors. Reflector units shall be installed in conformity with details shown on the plans and in accordance with the manufacturer's recommendations. Where holes are required to be bored in posts or other units, the holes shall be bored prior to the required painting. The reflectors shall be installed after all painting is completed.

606.04--Method of Measurement. Guard rail will be measured by the linear foot along the face of the rail from center to center of end posts for each complete section and will include posts and other elements of the completed section.

Special sections will be measured per each or linear foot, as indicated on the plans.

Guard posts will be measured by the unit per each post installed. Such measurement will include reflectors as specified, backfill, clean up, and any required additional hardware such as caps and chain necessary to complete the work.

606.05--Basis of Payment. Guard rail will be paid for at the contract unit price per linear foot for each designated type. Special sections will be paid for at the contract unit price per linear foot or per each, as applicable. Guard posts will be paid for at the contract unit price per each.

These prices shall be full compensation for completing the work.

Payment will be made under:

606-A: Guard Post	- per each
606-B: Guard Rail, <u>Designation</u>	- per linear foot
606-C: Guard Rail, Cable Anchor, <u>Designation</u>	- per each
606-D: Guard Rail, Bridge End Section, <u>Designation</u>	- per each
606-E: Guard Rail, Terminal End Section	- per each
606-F: Special Sections, <u>Designation</u>	- per linear foot or each

SECTION 607 - FENCES AND CATTLE GUARDS

607.01--Description. This work consists of furnishing materials and constructing fences, gates, and cattle guards in accordance with the plans and these specifications and in reasonably close conformity with the lines and grades indicated on the plans or established. Fencing shall include satisfactory connections with all intersecting fences, bridges, and culvert headwalls.

This work also consists of fencing designed and constructed primarily as screening or glare barrier. In this case certain modifications or amendments to these specifications shall be made as shown on the plans or in the proposal; otherwise, the requirements of these specifications shall be applicable.

607.02--Materials.

607.02.1--Type "A" Fence. Materials for Type "A" fence shall meet the requirements of the following subsections:

Woven Wire (Hog Wire)	712.03
Barbed Wire	712.02
Staples	712.15
Tension Wire	712.14
Tie Wire	712.13

607.02.2--Chain Link Fence. Materials for chain link fence shall meet the requirements of Subsection 712.04.

607.02.3--Posts and Lumber. The size of posts and lumber shall be as designated on the plans.

Unless otherwise specified, concrete posts for Type "A" fence shall be used in interchange areas. In other areas, either wood or concrete posts for Type "A" fence may be used, provided the same type is used throughout the project.

Posts shall meet the requirements of Subsection 712.05 for the type specified or permitted.

607.02.4--Gates. Gates shall meet the requirements of Subsection 712.12 for the type specified.

607.02.5--Concrete for Anchors and Footings. Concrete for anchors and footings shall be Class "C" conforming to the requirements of Section 804, except that the requirements for size and gradation of aggregate may be modified, and small, one-half cubic yard or less, batches may be mixed by approved hand methods.

607.02.6--Cattle Guards. Materials for cattle guards will be specified on the plans and in the special provisions.

607.03--Construction Requirements.

607.03.1--General. The Contractor shall perform the clearing and grubbing necessary to construct the fence to the required grade and alignment. Clearing and grubbing shall be in accordance with Section 201.

A herbicide shall be used for sprout control of cut stumps. Paint or spray freshly cut stump surface thoroughly covering cambium area next to bark until the herbicide runs down around the root collar. Treat stump as soon as practical after cutting for more effective control but no later than day of cutting except when

spraying must be postponed due to inclement weather. Pine stumps and all other stumps larger than 15 inches in diameter do not require spraying for control of sprouting. Permissible herbicides are 2,4-D (amine); picloram +2,4-D; ammonium sulfamate; and dicamba. Specific requirements such as mixing, diluting, rate, application, use restrictions, safety precautions, etc. will be in accordance with the manufactures printed container label.

Re-spraying will be required when the herbicide is washed off by rain within eight hours of application or diluted to such an extent to be ineffective.

At locations where breaks in a run of fencing are required, or at intersections with existing fences, appropriate adjustment in post spacing shall be made to conform to the requirements for the type of closure indicated.

All posts shall be set plumb and to the required grade and alignment. Cutting of the tops of the posts will be allowed only with the approval of the Engineer and under the conditions specified by the Engineer.

Wire or fencing shall be stretched taut and firmly attached to posts and braces by the method indicated on the plans. All wire shall be installed to the required elevations.

At each location where an electric transmission, distribution, or secondary line crosses the fence, the fence shall be grounded by a copper-coated steel rod at least eight feet long and at least 1/2 inch in diameter. The rod shall be installed directly below the point of crossing and driven vertically until the top is six inches below the ground surface. A No. 6 solid copper conductor or equivalent shall be used to connect each fence element to the grounding rod. The connections shall be either brazed or fastened with approved non-corrosive clamps.

When a power line runs parallel or nearly parallel to the fence, the fence shall be grounded at each end or gate post or at intervals not to exceed 1,500 feet.

Fences shall generally follow the contour of the ground, with the bottom of fence fabric not less than one inch nor more than six inches from the ground surface. Grading shall be performed where necessary to provide a neat appearance. Where abrupt changes in the ground profile in low areas make it impractical to maintain the ground clearance shown on the plans, longer posts may be used and multiple strands of barbed wire stretched thereon. The vertical clearance between strands of barbed wire shall be as shown on the plans.

On tangent sections fabric or wire shall be placed on faces of posts opposite the highway, and on curve sections on the faces of posts opposite the center of curvature.

607.03.2--Concrete and Timber Posts.

607.03.2.1--General. Post holes shall be of sufficient diameter to allow proper compaction of backfill. The backfill shall be made with the best soil available and shall be thoroughly tamped until the post is firm and rigid in position.

Round wood posts shall be set with the large end down and shall be plumbed to within a tolerance of 1/4 inch per foot of height. The top shall be set to within 1/2 inch of the specified alignment on the side to which the wire is to be attached.

Concrete and square wood posts shall be set plumb and to within 1/2 inch of the specified alignment on the side to which the wire is to be attached.

Fence posts not specified to be set in concrete may be erected by driving, drilling, or combination, when after demonstration at the project site the Engineer approves the results as being equal to or better than what can be obtained by erecting in dug holes and backfilling.

The use of mechanical driving equipment shall not require removal of more desirable trees or more grading than is required for dug holes.

607.03.2.2--Line Posts. When specified or directed, line posts at the low point of a grade or in depressions where the pull on the fence tends to lift the post shall be anchored in concrete.

607.03.2.3--Brace Bays. When the distance between end, gate, or corner posts exceeds 500 feet on tangent fences and 250 feet on curved fences, brace bays shall be erected.

607.03.2.4--Concrete Anchors. The surface of concrete anchors shall be shaped to drain away from the post. Anchors shall be covered with suitable earth and allowed to cure five days before installation of wire or fabric.

607.03.3--Metal Posts and Concrete Footings. Unless otherwise specified or permitted, holes for concrete footings shall be wetted sufficiently to prevent absorption of moisture from concrete. The concrete shall be finished above the ground to shed water and covered with four inches of loose earth. The footings shall be allowed to cure for seven days before erection of fabric.

When the ground is not firm, side forms will be required. Forms may be removed within 24 hours. Immediately after stripping the forms, moistened earth shall be tamped solidly around the footing, and four inches of loose earth shall be placed over the footing.

The distance between end, corner, intermediate brace, or gate posts shall not exceed 1,000 feet, and each such post shall be braced and trussed to the adjacent

line posts.

If specified, metal posts shall be erected without concrete footings. In this case, posts shall be driven plumb to within 1/2 inch of the specified alignment by means of an approved post driver. Posts which are bent or otherwise damaged shall be removed and replaced.

607.03.4--Installing Wire.

607.03.4.1--Woven Wire Fabric. Stretching shall be with an approved stretcher that will produce approximately equal tension in each line wire. The fabric shall be stretched until the tension is just below the point of producing displacement in the tension crimps. At each end, corner, or gate post, each strand of line wire shall be wrapped around the post and securely fastened by winding the free end around the wire near the post. Splicing shall be accomplished by the use of either a wrapped splice or a corrosion resistant, compressed sleeve type splice meeting the approval of the Engineer. When a wrapped splice is used, the vertical wires adjacent to each end shall be brought together and the end of each horizontal wire wrapped with at least six complete turns around the other corresponding horizontal wire.

607.03.4.2--Barbed Wire. Either a wrapped splice or the compressed sleeve type splice described above may be used for barbed wire. When the wrapped splice is used, each end shall be wrapped with at least six complete turns around the other wire.

607.03.4.3--Chain Link Fabric. Continuous mesh shall be afforded by weaving and fastening rolls of fabric together with a single wire strand of the size and type in the fabric.

607.03.5--Gates. Posts and footings or anchorages shall be installed in the manner prescribed for the post type used.

When the type latching device so requires, a concrete "keeper" or footing, minimum 12 x 12 x 15 inches of the type necessary to seat the drop-bar firmly, shall be constructed.

607.03.6--Finished Fence. The tops of all posts shall be at a uniform grade and at a uniform distance above the top wire.

All surplus excavated material and debris resulting from construction shall be disposed of as directed and the fence left in a neat and orderly condition.

607.03.7--Cattle Guards. Construction details for cattle guards will be set out in the special provisions.

607.04--Method of Measurement. Type "A" woven wire fence, of the height specified, will be measured by the linear foot of completed fence which includes woven wire, barbed wire, and other appurtenances shown on the plans. Measurement will be made along the bottom of the woven wire fabric, and openings will be excluded from the measurement.

Chain link fence, of the height specified, will be measured by the linear foot of completed fence. Measurements will be made along the bottom of the chain link fabric, and openings will be excluded.

Barbed wire fence of the number of strands specified will be measured by the linear foot of completed fence. Measurements will be made along the completed fence, and openings will be excluded.

Single strand barbed wire indicated for separate payment will be measured by the linear foot.

Gates will be measured by the unit.

Posts, including tops and footings of metal posts, will be measured by the unit.

Concrete anchors for use with timber or concrete posts will be measured by the unit.

Pickets will be measured by the linear feet of completed fence containing pickets. Lattice will be measured by the linear feet of completed fence containing lattice.

Cattle guards will be measured per each.

Excavation and backfill for footings, anchorages, and cattle guards; stretcher bars; top rails; post tops; barbed wire integral to specified fences; bottom tension wires or rails; tie wires; tension wires; truss rods with turnbuckles; connectors; bands; compression braces; hinges; latching devices; hardware; reflectors; paint; painting; and other accessories and incidentals necessary to complete the work will not be measured for separate payment.

Required clearing and grubbing and grading will not be measured for separate payment unless so indicated on the plans.

607.05--Basis of Payment. Fencing items will be paid for at the contract unit prices for the respective items, which shall be full compensation for completing the work.

Payment will be made under:

607-A: ____" Type "A" Woven Wire Fence

- per linear foot

Section 607	Section 607
607-B: ____” Type ____ Chain Link Fence *	- per linear foot
607-C: ____” Type ____ Chain Link Fence, <u>Glare Barrier / Screening</u>	- per linear foot
607-D: Barbed Wire Fence, <u>No. Strands & Materials</u>	- per linear foot
607-E: Barbed Wire, Single Strand	- per linear foot
607-G: Gate, <u>Size & Type</u> *	- per each
607-H: Pickets, <u>Height, Size and Material</u>	- per linear foot
607-L: Lattice, Height, <u>Size, Material, etc.</u>	- per linear foot
607-P1: Line Posts, <u>Length, Size & Material</u>	- per each
607-P2: Brace Posts, <u>Length, Size & Material</u>	- per each
607-P3: Gate Posts, <u>Length, Size & Material</u>	- per each
607-W: Cattle Guards	- per each
607-Z: Concrete Anchors	- per each

* Indicate when arms with barbed wire is required

SECTION 608 - CONCRETE SIDEWALKS

608.01--Description. This work consists of constructing portland cement concrete sidewalks on a prepared subgrade in accordance with the plans and specifications. Lines and grades shall be as shown on the plans or established. "Subgrade" in this section shall mean the prepared foundation on which the sidewalk is constructed.

608.02--Materials. All material furnished for use shall comply with appropriate requirements of the 700 series of these specifications, and the following:

Concrete shall be Class B meeting the requirements of Section 804 or Class P or PA meeting the requirements of Section 501.

Reinforcing steel shall meet the applicable requirements of Sections 602 and 711 and plan details.

608.03--Construction Requirements.

608.03.1--Equipment. The Contractor may use forms or, if requested in writing and approved by the Engineer, an approved automatic extrusion type paving machine.

Forms shall be wood or metal. If wood, they shall be dressed on all sides, and be free of bulges, warps, and loose knots. If metal, they shall be of approved section and have a flat surface on top. The depth of the forms shall be equal to the depth of the sidewalk. Adequate means shall be provided for securely fastening the ends of forms together.

Prior to use, an automatic extrusion machine must be demonstrated to produce a consolidated concrete section conforming to the dimensions, cross section, line, and grades shown on the plans or established.

608.03.2--Excavation and In-Grade Preparation. Excavation shall be made to the required depth and to a width that will permit the installation and bracing of forms. The foundation shall be shaped and compacted at the proper moisture content to a firm, even surface conforming to the lines, grades, and sections shown on the plans or established. All soft, spongy, or other unsuitable materials encountered shall be removed and replaced with acceptable material.

608.03.3--Setting Forms. Forms shall be set to the required line and grade and rigidly held in place by stakes or braces. Ends of adjoining form sections shall be flush. Forms and division plates shall be cleaned and oiled before placing concrete against them.

608.03.4--Handling, Measuring, Proportioning, and Mixing Materials. The method of handling, measuring, proportioning, and mixing concrete materials shall conform to Section 501 or Section 804. Where reinforcement is required, it shall be placed in accordance with Section 602.

608.03.5--Placing Concrete. A template resting upon the side forms and having its lower edge at the elevation of the subgrade shall be drawn along the forms to shape and grade the subgrade before concrete is deposited. The subgrade shall be moist and free of debris and foreign material before concrete is deposited upon it. The concrete mixture shall be placed on the prepared subgrade to the depth required to complete the sidewalk in one course. It shall then be vibrated and/or tamped and struck off with an approved straightedge resting upon the side forms and drawn forward with a sawing motion. The surface shall be given a Class 6 float finish as set out in Section 804.

The edges of sidewalk shall be rounded with an edging tool having a radius of 1/2 inch. Expansion joints shall be edged with an edger having a radius of 1/4 inch.

608.03.6--Joints. Expansion joints shall be of the dimensions specified and shall be filled with the type of premolded expansion joint filler specified. Sidewalks shall be divided into sections by dummy joints formed by a jointing tool or other acceptable means. These dummy joints shall extend into the concrete for at least one inch and shall be approximately 1/8 inch wide. Joints shall match as nearly as possible adjacent joints in curb or pavements. Dummy joints may be sawed in lieu of forming with a jointing tool.

Construction joints shall be formed around all appurtenances such as manholes, utility poles, etc. extending into and through the sidewalk. Premolded expansion joint filler 1/4 inch thick shall be installed in these joints. Expansion joint filler of the thickness indicated shall be installed between concrete sidewalks and fixed structure such as a building or bridge. This expansion joint material shall extend for the full depth of the walk.

608.03.7--Protection and Curing. Concrete shall be protected and cured in accordance with the requirements of Subsection 501.03.20 or by other approved methods.

Placement, protection, and curing of concrete during cold or hot weather shall conform to the limitations, conditions, and requirements set out in Section 804.

608.03.8--Backfilling and Cleaning Up. When the concrete has set sufficiently, the sides of the walk shall be backfilled and compacted to the required elevation with suitable material. All surplus material shall be disposed of as directed, and the completed work and the site shall be left in a neat and presentable condition.

608.04--Method of Measurement. Concrete sidewalks of the type specified will be measured for payment by the square yard.

Excavation, backfill, expansion joint material, and other miscellaneous items will not be measured for separate payment.

608.05--Basis of Payment. Concrete sidewalks will be paid for at the contract unit price per square yard, which shall be full compensation for completing the work.

Payment will be made under:

608-A: Concrete Sidewalk, Without Reinforcement	- per square yard
608-B: Concrete Sidewalk, With Reinforcement	- per square yard

SECTION 609 - CONCRETE GUTTER, CURB, AND COMBINATION CURB AND GUTTER

609.01--Description. This work consists of constructing curb, gutter, and combination curb and gutter in accordance with these specifications and in reasonably close conformity with the lines, grades, dimensions, and cross sections shown on the plans or as established.

609.02--Materials. Concrete for detached curb, gutter, and combination curb and gutter shall meet the requirements of Section 601. Concrete for curbs integral with concrete pavement shall meet the requirements of Section 501.

Mixtures for bituminous curb shall be in accordance with Sections 401 and 403 and, unless otherwise specified or approved, shall be a Type ST, 12.5 mm mixture.

609.03--Construction Requirements.

609.03.1--Excavation and In-Grade Preparation. Excavation and in-grade preparation for gutter, curb, and combination curb and gutter shall be performed in accordance with the applicable provisions of Section 321.

609.03.2--Cast-in-Place Portland Cement Concrete.

609.03.2.1--Forms. Forms, except for divider plates and templates, may be wood or metal. All forms shall be full depth, straight, and free of warp and shall be securely staked, braced, and sufficiently tight to prevent leakage of mortar. All forms shall be cleaned thoroughly and oiled before placing concrete against them.

Lumber for wood forms shall be sound, free of bulges, loose knots, and warps, and of uniform width. All lumber shall be dressed commercial lumber at least two inches thick, except the Engineer may permit the use of flexible material on short radii.

Metal forms shall be of approved sections and shall have a flat surface on top. They shall present a smooth surface and be of sufficient strength when braced to withstand the weight of the concrete without bulging or displacement. Special care shall be exercised to keep metal forms free from rust, grease, or other foreign matter which would discolor the concrete.

Metal templates or dividing plates shall be of sufficient thickness and of such design as to hold the forms rigidly in place and to produce a smooth vertical joint after the plates are removed. They shall be of the full dimensions shown on the plans for curb, gutter, or combination curb or gutter.

609.03.2.2--Proportioning, Mixing, and Placing Concrete. Unless otherwise specified, concrete used for detached curb, gutters, and combination curb and gutter shall be Class "B" proportioned, mixed, and placed in accordance with the provisions of Section 601.

Concrete used for curb integral with concrete pavement shall be proportioned, mixed, and placed in accordance with the provisions of Section 501.

The concrete shall be placed on a moist grade and consolidated by vibration or other acceptable methods. Weep holes shall be placed through curbs where indicated on the plans or as directed.

609.03.2.3--Extruded Construction. Concrete curb and curb and gutter may be constructed by the use of a curb forming machine. Such a machine shall conform to (a), (b), and (e) of Subsection 609.03.3.2, and in addition, its continued use shall be contingent upon it producing curb with the specified section, line, and grade. If these conditions cannot be met, construction shall be by conventional methods.

In the event a curb forming machine is used, minor modifications in the concrete mix design may have to be made to improve placement, subject to approval of the State Materials Engineer.

609.03.2.4--Sections and Joints. Concrete curb, gutter, or combination curb and gutter shall be constructed in uniform sections of the length specified on the plans. These lengths may be reduced where necessary for closure but no section less than six feet will be permitted. The templates shall be accurately set before placing the concrete and allowed to remain in place wherever possible until the concrete has set sufficiently to hold its shape, but shall be removed while the forms are still in place.

Expansion joints shall be formed of premolded joint filler of the specified thickness, and shall be placed in line with expansion joints in the adjoining pavement or structure and at other locations designated on the plans. All joint fillers shall be cut to full cross section and shall extend for full depth, width, and length. All expansion joint material protruding after the concrete is finished shall be trimmed as directed. Immediately after removal of forms, the outer edges of filled joints shall be carefully exposed.

609.03.2.5--Finishing. The concrete shall be finished smooth and even by an approved float. Forms on the face of curbs shall be removed as soon as the concrete will hold its shape, and the surface shall be finished with a float to a smooth even texture. Plastering will not be permitted. Strike-off templates of the form and shape of the gutter shall be used to shape the top surface of gutters. Before final finishing the surface of gutters shall be checked with a 10-foot straightedge, and all irregularities of more than 1/8 inch in 10 feet shall be

corrected.

Edges on the faces of curbs shall be rounded with finishing tools having the radii shown on the plans. Edges where templates have been removed or expansion joint material has been placed shall be finished with an edging tool having a radius of 1/4 inch. All exposed surfaces against which some rigid type of construction is to be made shall be left smooth and uniform so as to permit free movement of the curb, gutter, or combination curb and gutter.

All tool marks shall be removed with a wetted brush or wood float. The finished surface shall be a uniform color free from discolorations.

609.03.2.6--Protection and Curing. Concrete shall be cured for at least 72 hours. Curing shall be by moist cotton or burlap mats, waterproof paper, white polyethylene sheeting, straw curing as set out in Subsection 501.03.20, or by other approved methods.

The Contractor shall have materials available at all times for the protection of unhardened concrete against rain. During the curing period all traffic, both pedestrian and vehicular, shall be kept off the concrete. Vehicular traffic shall be kept off for such additional time as the Engineer may direct. The Contractor shall protect the work from damage until release of maintenance. All sections which are damaged before release of maintenance shall be removed and reconstructed by the Contractor without extra compensation.

609.03.3--Bituminous Curbing.

609.03.3.1--Preparation of Bed. When curbing is to be constructed on a newly placed bituminous surface, the curb may be laid if the surface is clean.

When curbing is to be constructed on concrete or bituminous pavement that is not newly placed, the bed shall be thoroughly swept and cleaned by compressed air. The surface shall be dry, and immediately prior to placement of the curb shall be tacked with bituminous material of the type and grade approved by the Engineer. The rate of application of the tack coat material shall be between 0.05 to 0.15 gallons per square yard of surface. The Contractor shall prevent the tack coat material from spreading to areas outside that to be occupied by the curb.

609.03.3.2--Placing. Bituminous curbing shall be constructed with a self-propelled curbing machine or paver with curbing attachments designed to extrude and compact the material in accordance with the typical section on straight and curved alignments.

The automatic curb machine shall meet the following requirements and shall be tentatively approved prior to its use. Its continued use shall be contingent upon its production of curbing meeting the specified requirements.

- (a) The weight of the machine shall be such that the required compaction is obtained without the machine riding above the specified grade.
- (b) The machine shall be capable of laying the curb to the dimensions and position specified.
- (c) The machine shall be capable of ironing the curbs smoothly with a heat-jacketed mold and of compacting the curb to at least 90 percent of theoretical density.
- (d) When curbing is to be placed on an existing bituminous surface the machine shall be capable of preheating the surface.
- (e) The machine shall form curbing that is uniform in texture, shape, and density.
- (f) The Engineer may permit construction by other means for short sections, sections with short radii, or for other reasons warranted by the Engineer. The resulting curbing shall conform in all respects to the curbing produced by the use of the machine.

609.03.3.3--Painting. When painting is required, it shall consist of two coats of the specified traffic paint meeting requirements of Section 625. Glass beads shall also conform to the requirements of Section 625 and shall be applied onto the top coat of paint in a manner that will embed the beads sufficiently to adhere to the painted surface.

609.03.4--Backfilling and Cleaning Up. After the concrete has set sufficiently or the bituminous curb has cooled, the areas on the sides of the curb, gutter, and combination curb and gutter shall be filled to the required elevation with the specified materials and compacted as specified or directed.

All surplus material shall be disposed of as directed, and the entire area shall be left in a neat and satisfactory condition.

609.04--Method of Measurement. Concrete gutter, curb, combination curb and gutter, and bituminous curb will be measured by the linear foot along the face of the curb or flow line of the gutter. Deduction will be made for driveway openings.

Concrete integral curb, complete in place, will be measured by the linear foot along the face of the curb including the full length of curb returns for driveways.

No deduction in length will be made for drainage structures such as catch basins and inlets installed in the curbing.

Excavation, backfill, expansion joint material, and other related miscellaneous items will not be measured for separate payment. The cost thereof shall be included in the unit prices bid for other items.

609.05--Basis of Payment. Concrete gutter, curb, combination curb and gutter, and bituminous curb will be paid for at the contract unit prices per linear foot, complete in place, which shall be full compensation for completing the work.

Payment will be made under:

- 609-A: Concrete Gutter, Designation - per linear foot
- 609-B: Concrete Curb, Type ____ - per linear foot
- 609-C: Concrete Integral Curb, Type ____ - per linear foot
- 609-D: Combination Concrete Curb and Gutter * - per linear foot
- 609-E: Bituminous Curb - per linear foot
- * Type may be specified

SECTION 610 - DRAINAGE WICKS

610.01--Description. This section shall cover the work of furnishing and installing drainage wicks of the types, sizes and at the designated locations, all in accordance with the details specified on the plans and in these specifications or as directed by the Engineer.

This section shall also cover the work of drilling holes through the embankment layer at locations specified on the plans or directed by the Engineer. Jetting methods will not be permitted.

The Engineer may vary the depths, spacings or number of drainage wicks to be installed, and may revise the plan limits for this work as necessary.

610.02--Materials. The drainage wick shall be a prefabricated type composed of a drainage plastic core wrapped in a non-woven geotextile. The core shall be fabricated with suitable drainage channels.

The non-woven geotextile wrap shall meet the following minimum specifications:

<u>Property</u>	<u>Value</u>	<u>Test Method</u>
Tensile Strength	30 lbs./in.	ASTM Designation: D 4632
Permittivity	0.15 sec ⁻¹	ASTM Designation: D 4491

The core material shall be constructed in such a manner that the filter geotextile has a minimum surface area of 3.50 square inches per inch that is not in contact with the core material. The core channels shall have a minimum free volume of 0.16 cubic inch per inch.

The Contractor will be required to furnish to the Engineer three copies of a certified test report from the producer, showing all data required to indicate compliance with the above specifications and with certification that the material meets such specifications.

The certifications by the manufacturer or distributor will be prima-facie evidence of the materials meeting the specified requirements. All drainage wick materials will, however, be subject to approval by the Engineer.

610.03--Construction Requirements.

610.03.1-- Equipment. In general, it shall be the Contractor's responsibility to select the proper sizes and amount of equipment to provide the desired results, but the following basic items shall be provided. The type of carrier to be used will depend upon the desired installation force, but it shall be equipped with a mandrel or sleeve of minimum cross sectional area not to exceed fourteen square inches which will protect the wick material from tears, cuts and abrasions during installation.

The Contractor shall secure approval of all equipment prior to beginning work and any equipment found unsatisfactory shall be promptly replaced or supplemented. All equipment approved for use shall be on a trial basis, and should after a short test section the equipment prove unsatisfactory, it shall be removed, replaced or supplemented as deemed necessary to accomplish the desired results.

610.03.2--Installation. At least two weeks prior to the installation of the drainage wicks, the Contractor shall submit to the Engineer for review and approval, details of the sequence and method of installation. Approval by the Engineer of the sequence and method of installation shall not constitute necessarily, acceptance for the duration of the project. If, at any time, the Engineer considers that the method of installation does not produce a satisfactory drainage wick, the Contractor shall alter the installation method and/or equipment as necessary to comply with these specifications.

The Contractor will be permitted to use augers or other approved methods to loosen stiff upper soils prior to the installation of the drainage wicks. These holes shall have a maximum diameter just large enough to permit the mandrel or sleeve carrying the wick and wick anchorage to penetrate the embankment and shall extend not more than two feet into the underlying highly compressible soil. The drainage wick shall be installed at the designated locations using a mandrel

or sleeve which completely encloses the drainage wick, thereby protecting it from tears, cuts and abrasions during installation. The mandrel, with the wick inside, shall be forced vertically into the ground to an elevation specified on the plans or directed by the Engineer. The mandrel shall be retracted leaving the wick in place to function as a vertical drain. The wick shall be cut neatly at its upper end with an eight-inch length of wick material protruding above the existing embankment surface.

The equipment shall be carefully checked for plumbness prior to advancing each wick and must not deviate more than one inch per foot from the vertical. Wicks that are out of their proper location by more than six inches, damaged in construction or improperly completed shall be rejected by the Engineer, and no compensation will be allowed for said rejected wicks.

The Contractor shall provide a suitable means of making a linear determination of the depth of the drainage wick at any given time and of the quantity of wick material used at each vertical drain location.

The Contractor shall observe precautions necessary for protection of instrumentation devices and shall replace at no additional cost to the State any equipment that is damaged or becomes unreliable as a result of the Contractor's operations.

Embankment or surcharge to be placed over an area in which drainage wicks are installed shall be allowed to settle the period of time as specified on the plans. In the case of bridge approach embankment fills, no end bent piling may be driven until the specified waiting period has elapsed. The waiting period begins when the total embankment and/or surcharge has been constructed to grade.

If no settlement monitoring devices are specified on the plans, the Contractor may propose to provide, install and maintain subsidence/settlement plates and essential appurtenances for the Engineer to measure the amount of settlement that occurs. If the data taken from these settlement plates shows that the amount of settlement is sufficient, or that the rate of settlement has declined to the point that little additional settlement will occur during the specified waiting period, the Contractor will be relieved of the total waiting period requirement. In the case of bridge approach embankment fills, the end bent piling may then be driven without further delay. The settlement measuring devices shall be approved by the Engineer.

610.04--Method of Measurement. Drainage wicks will be measured by the linear foot for the full length of drainage wicks, complete and in place. No separate measure for payment will be made for loosening of stiff upper soils by augering or other approved methods.

610.05--Basis of Payment. Drainage wicks, measured as prescribed above, will

be paid for at the contract unit price per linear foot, which price shall be full compensation for all drilling of holes, furnishing all materials, installation of drainage wicks and for all labor, equipment, tools and incidentals necessary to complete the work.

Payment will be made under:

610-A: Drainage Wicks

- per linear foot

SECTION 611 - BRICK MASONRY

611.01--Description. This work consists of constructing brick masonry structures in accordance with these specifications and in reasonably close conformity with the lines, grades, dimensions, and details shown on the plans or as directed.

611.02--Materials. Masonry brick shall be new, whole brick of standard commercial size with straight and parallel edges and square corners. They shall be Grade SW or Grade SM as specified and shall meet the requirements of Subsection 706.01.

Unless otherwise specified, the following use requirements shall govern:

- (a) Grade SW brick shall be used in exposed masonry.
- (b) Grade SM brick shall be used in catch basins, inlets, manholes, and other sewer or drainage structures.

Mortar for brick masonry shall conform to the applicable requirements of Subsection 714.11.

611.03-Construction Requirements.

611.03.1--Excavation. Excavation for brick masonry shall be performed in accordance with the provisions of Subsection 604.03.7.

611.03.2--Laying Brick. Brick masonry shall not be constructed in freezing weather or when bricks contain frost except by written permission of the Engineer and subject to the conditions set forth.

Brick for exposed surfaces, corners, etc. shall be selected for color and uniformity.

Mortar shall be mixed only in quantities required for immediate use. See Subsection 714.11.5 for more information on masonry mortar.

Brick shall be laid upon prepared foundations in accordance with the design indicated on the plans or as directed. All brick shall be thoroughly cleaned and saturated with water immediately prior to laying. They shall be laid in courses and in a manner that will thoroughly bond them into the fresh mortar by means of the "shove joint" method. "Buttered" or plastered joints will not be permitted. The arrangement of headers and stretchers shall be that which will thoroughly bond the mass. Unless otherwise specified, brick work shall be of alternate headers and stretchers with consecutive courses breaking joints. Other types of bonding, such as for ornamental work, will be specified on the plans.

All joints shall be completely filled with mortar. They shall not be less than 1/4 inch nor more than 1/2 inch in thickness, and the thickness shall be uniform throughout. All joints shall be finished properly as the work progresses, and on exposed walls they shall be neatly struck using the "weather" joint.

Bats or spalls shall not be used except for shaping around irregular openings or when unavoidable to finish out a course. When used to finish out a course, full bricks shall be placed at the corners and the bats placed in the interior course. Filling materials for the interior of the walls shall be the same quality as used in the face of the unit unless otherwise indicated on the plans or directed.

Weep holes shall be constructed as shown on the plans or as directed.

In case a brick is moved or the joint broken after laying, the brick shall be taken up, the mortar thoroughly cleaned from the brick bed and joint, and the brick relaid in fresh mortar.

In hot or dry weather, brick masonry shall be protected and kept wet for a period of at least 48 hours after the brick are laid.

Only expert bricklayers shall be used for this work, and all details of the construction shall be in accordance with approved and satisfactory practice.

All exposed masonry shall present an even, uniform, neat, and workmanlike appearance, and the exposed surfaces shall be thoroughly cleaned of all mortar and scars and the surface left the natural color of the brick.

611.03.3--Backfill. Backfill for brick masonry shall be in accordance with the provisions of Subsection 203.03.8.6.

611.04--Method of Measurement. Brick masonry will be measured by the cubic yard or by the thousand. The unit for measurement will be indicated on the bid sheet.

When measurement is by the cubic yard, the volume will include the mortar.

When measurement is by the thousand, the mortar will not be measured for payment.

When either concrete masonry or brick masonry is permitted under Subsection 604.03.4, measurement will be made in accordance with Subsection 604.04.

Excavation for brick masonry will not be measured for payment.

611.05--Basis of Payment. Brick masonry will be paid for at the contract unit price per cubic yard or per thousand, as indicated, which shall be full compensation for completing the work.

When brick masonry is used as an optional item of construction under Subsection 611.04, payment will be made as provided in Subsection 601.05.

Payment will be made under:

611-A: Brick Masonry - per cubic yard or thousand

SECTION 613 - ADJUSTMENT OF CASTINGS, GRATINGS, AND UTILITY APPURTENANCES

613.01--Description. This work consists of furnishing all materials and adjusting existing catch basins, inlets, manholes and other designated structures in accordance with these specifications and in reasonably close conformity with the lines, grades and dimensions shown on the plans or as established.

613.02--Materials. New materials used in this construction, unless otherwise stipulated, shall conform to the requirements set out in Section 604.

613.03--Construction Requirements.

613.03.1--General. Construction requirements shall be, insofar as applicable, as described in Section 604. Castings, gratings, frames, covers, and other metal units shall be cleaned before resetting.

Where a casting, grating, or utility appurtenance is to be lowered, the masonry shall be removed to sufficient depth so that a set of proper dimensions may be reconstructed to receive the casting, grating or utility appurtenance at the new grade. Where the castings, grating or utility appurtenance is to be raised less than one foot, a new ring of masonry may be added without disturbing the old masonry. The use of metal rings to raise appurtenances will be allowed with approval of the Engineer. Where the distance to be raised exceeds one foot, the old masonry shall be removed to sufficient depth, as directed, to permit a neat and workmanlike extension to the new grade.

The Contractor shall replace, at no additional cost to the State, all units or parts indicated to be salvaged and reused which are damaged as a result of the Contractor's operation.

613.03.2--Cleaning Up. Upon completion of the adjustment, all surplus material shall be removed, and the structure and site of the work shall be left in a neat and clean condition. The entire structure shall be thoroughly cleaned of accumulations of silt, debris, or foreign matter of any kind and shall be kept clean until the final inspection.

613.04--Method of Measurement. Adjustment of castings, gratings, utility appurtenances, etc. for which pay items are included in the contract will be measured on a lump sum basis or by the number of units, as specified.

613.05--Basis of Payment. Adjustment of castings, gratings, and utility appurtenances for which pay items are included in the contract will be paid for at the contract lump sum price or at the contract unit price per each, as indicated, which shall be full compensation for completing the work.

Payment will be made under:

613-A: Adjustment of Castings, Gratings and Utility Appurtenances	- lump sum
613-B: Adjustment of Castings	- per each
613-C: Adjustment of Gratings	- per each
613-D: Adjustment of <u>Description</u>	- lump sum or per each

SECTION 614 - CONCRETE DRIVEWAYS

614.01--Description. This work consists of furnishing all materials and constructing cement concrete driveways on a prepared grade in accordance with these specifications, at the locations, and in reasonably close conformity with the lines, grades, and typical sections as shown on the plans or as established.

614.02--Materials. Unless otherwise stipulated, the materials used in this construction, in addition to conforming with the requirements of Division 700 for materials specified and used, shall conform to the following:

- (a) Concrete. The materials used in the manufacture of concrete shall conform to the requirements for the type of concrete pavement used in the roadway as set out in Section 501, or shall conform to the requirements for Class "B" concrete as set out in Section 804, as shown

on the plans and in the proposal, or as otherwise indicated in the contract.

- (b) Expansion Joint Filler. Expansion joint filler shall be either premolded or poured and shall conform to the requirements as set forth in Section 707 for the particular type specified.

614.03--Construction Requirements.

614.03.1--Equipment. The equipment shall conform to the requirements of Section 501 or Section 804, as applicable. All small tools, such as edgers, floats, tamps, etc., shall be approved tools of such quality and quantity as to assure their adequacy in the performance of acceptable work. Approved equipment, necessary and required, shall be on the project in good working condition before construction will be permitted to start.

614.03.2--Preparation of Grade. In-grade preparation shall be performed in accordance with the applicable provisions and requirements of Section 321, unless otherwise specified or directed by the Engineer, within the tolerances set out in Subsection 321.03.7, extending such preparation, unless otherwise specified, to at least two (2) feet beyond the edges of the proposed concrete driveway.

614.03.3--Forms. Forms and forming shall conform with the requirements of Subsection 608.03.3.

614.03.4--Manufacturing and Placing Concrete. The concrete used in the construction of driveways shall be manufactured, proportioned and placed in accordance with the requirements of Section 501 or Section 804 as shown on the plans and in the proposal.

Prior to the placing of any concrete the grade shall be tested with a template cut true to cross-section of the proposed construction, all irregularities corrected and compacted, and the entire grade sprinkled with water.

Immediately after mixing, the concrete shall be deposited in a single layer on the moist grade to such depth that after finishing it shall be of the full thickness required. The edges, sides, etc., shall be thoroughly spaded, and the surfaces tamped sufficiently to compact the concrete and bring mortar, for finishing, to the surface.

Curb returns for driveways shall be constructed to the dimensions and section shown on the plans or as directed, using the same concrete mixture as used for the driveway slab. They shall be constructed monolithic with the slab as specified for integral curb in Section 609.

614.03.5--Finishing. The concrete shall be struck-off with a transverse template

resting upon the side forms, and shall be floated, with an approved float, in such a manner that excess water, laitance, or other inert material shall be removed from the surface. When the surface of the concrete is free from water and just before it obtains its set, it shall be finished with a wooden float so as to produce a sandy texture.

The edges of the concrete at expansion joints shall be edged with an edger having a radius of one-half (1/2) inch.

Curb returns shall be finished as specified for integral curb in Section 609.

614.03.6--Expansion Joints. Expansion joints shall be formed of premolded joint filler or poured filler of the specified thickness, and shall be placed at the locations indicated on the plans. All joint fillers shall be cut to full cross-section and shall extend to the full depth, width and length of the construction. Any expansion joint material extruding after the concrete is finished, shall be trimmed as directed.

614.03.7--Protection and Curing. After the concrete is completed, it shall be protected and cured in accordance with the requirements of Subsection 501.03.20 or other approved method.

Conditions governing the placement of concrete and the requirements for the placement, protection and curing of concrete during cold or hot weather shall conform to the limitations, conditions and requirements of Subsection 804.03.16 as applicable.

614.03.8--Backfilling and Cleaning Up. When the concrete has set sufficiently, the sides of the driveway shall be backfilled to the required elevation with suitable material, which shall be tamped in layers of not more than six (6) inches until firm and solid. All surplus material shall be disposed of as directed, and the completed work and the site shall be left in a neat and presentable condition.

614.04--Method of Measurement. Concrete driveways of the type specified will be measured for payment by the square yards. Driveway areas shall be defined as follows:

- (a) Where the driveway joins pavement and integral curb construction, the driveway area shall include the entire paved area back of the normal back of curb line.
- (b) Where the driveway joins combined curb and gutter construction, the driveway area shall include the entire paved area back of the normal line of the inside face of the gutter. The division line between combined curb and gutter and driveway area shall be that point designated as the beginning of the curb return.

614.05--Basis of Payment. Concrete driveways, measured as prescribed above, will be paid for at the contract unit price per square yard, which price shall be full compensation for curb returns; all backfilling and disposal of surplus materials; and for all materials, forms, equipment, tools, labor and incidentals necessary to complete the work.

Payment will be made under:

614-A: Concrete Driveway, Without Reinforcement * - per square yard

614-B: Concrete Driveway, With Reinforcement * - per square yard

* Thickness may be specified

SECTION 615 - CONCRETE BARRIER

615.01--Description. This work consists of furnishing all materials and constructing concrete barrier in accordance with these specifications and the details shown on the plans and in reasonably close conformity with the dimensions, lines, grades, and elevations shown on the plans or established by the Engineer.

615.02--Materials. Materials used in this work shall be in accordance with the applicable requirements of Section 700 or as shown on the plans.

Unless otherwise specified, concrete for barrier, cast-in-place or slipform placement, shall be Class "B" meeting the requirements of Section 804.

Concrete for precast barrier using the dry-cast plant manufacturing process shall produce 5,000 psi compressive strength in 28 days.

615.03--Construction Requirements.

615.03.1--General. Cast-in-place barrier shall be constructed in accordance with the requirements of Subsection 813.03.2.2 and applicable requirements of Section 804.

Barrier constructed by slipform placement shall be constructed in accordance with the requirements of Subsection 615.03.2 and applicable requirements of Section 804.

Precast barrier shall be constructed in accordance with applicable requirements of Section 804 and the requirements of Subsection 813.03.2.3, except concrete material requirements will be as set forth in Subsection 615.02. Precast concrete barriers must meet the requirements of NCHRP Report 350.

Joints shall be as shown on the plans, and the surface finish shall be Class 2, rubbed or spray finish, in accordance with the requirements of Subsection 804.03.19.3.

615.03.2--Slipform Placement. When concrete median barrier is placed by the slipform method, the slipform machine shall be crawler mounted for stability and shall include automatic sensing and control equipment for controlling line and grade. Continuation of placement by the slipform method shall be contingent upon quality workmanship and good configuration, lines and grades with very little hand finishing required. The Contractor shall be fully responsible for placement at no additional cost to the State, any and all barrier not conforming with the requirements of the contract. To improve placement characteristics, the State Materials Engineer may make minor modifications in the concrete mix design for this type of placement.

615.04--Method of Measurement. Concrete barrier of the type specified will be measured by the linear foot out to out of the barrier. This measurement shall include all elements of the barrier and its foundation.

615.05--Basis of Payment. Concrete barrier, of the type specified, will be paid for at the contract unit price per linear foot, complete-in-place, which shall be full compensation for completing the work.

Payment will be made under:

615-A: Concrete <u>Description</u> Barrier	- per linear foot
615-B: Precast Concrete <u>Description</u> Barrier	- per linear foot

SECTION 616 - MEDIAN AND ISLAND PAVEMENT

616.01--Description. This work consists of constructing paved medians and islands on prepared grades in accordance with these specifications and in reasonably close conformity with the lines, grades, and sections shown on the plans or established. When so indicated on the plans, this work shall also consist of painting the surface, or portions thereof, of the median or island.

616.02--Materials.

616.02.1--Concrete. The materials used in the manufacture of concrete shall conform to the requirements of Section 804 for the class of concrete specified. Unless otherwise specified, Class "C" concrete shall be used.

616.02.2--Joint Filler. Joint filler shall be the type specified on the plans and shall conform to the requirements of Section 707. Unless otherwise specified,

the filler shall be ½-inch premolded filler meeting the requirements of Subsection 707.02.2.

616.02.3--Hot Mix Asphalt Pavement. Hot mix asphalt pavement shall be in accordance with the applicable materials and construction requirements of Sections 401 and 403.

616.03--Construction Requirements.

616.03.1--Equipment. The equipment shall conform to the applicable requirements of Sections 401, 501, and 804, except that approved modified placement, shaping, compacting, and finishing equipment will be permitted. All small tools, such as edgers, floats, tamps, etc., shall be approved tools of such quality and quantity as to assure their adequacy in the performance of acceptable work. Approved required equipment shall be on the project in good working condition before construction will be permitted to start.

616.03.2--Preparation of Grade. Unless otherwise specified, in-grade preparation shall be performed in accordance with the applicable provisions of Section 321. After completion of grade preparation, the entire area shall be treated with a soil sterilant as follows:

- (a) Soil sterilant material shall be applied at the maximum rate recommended on the manufacturer's label for perennial weed control. Any granular or pelletized type soil sterilant that is approved by the Engineer may be used. The approved material shall be uniformly spread over the entire area immediately prior to placing the pavement.
- (b) The chemical compounds shall be delivered to the job in unbroken containers with the manufacturer's label thereon.
- (c) The Contractor shall be responsible for performing all precautions as shown on the label of the containers and shall be liable for any injury or damage caused from handling or using the material until acceptance of the project.
- (d) Furnishing and placement of soil sterilant shall be absorbed in the cost of the other bid items.

616.03.3--Forms. Forms will not ordinarily be required. If specified or necessary, forms and forming shall be in accordance with the requirements of Subsection 608.03.3.

616.03.4--Manufacturing and Placing Concrete. Concrete for this work shall be manufactured and placed in accordance with the requirements of Section 501 or Section 804 except that approved modified methods of placement, shaping, and compacting will be permitted. Concrete surfaces shall be given a Class 6 float finish in accordance with Subsection 804.03.19.5.

The fresh concrete shall be deposited in a single layer on a moist grade. The edges, shall be thoroughly spaded, and the surface shall be tamped sufficiently to compact the concrete and bring mortar for finishing to the surface.

The finished surface shall conform closely to the typical section indicated on the plans and shall not have irregularities which would prohibit complete surface drainage, including drainage over adjacent curb.

The edges of the concrete at expansion joints shall be edged to a radius of 1/2 inch.

616.03.5--Expansion Joints. Unless otherwise shown on the plans, expansion joints shall be formed of premolded joint filler of the specified thickness. All joint fillers shall be cut to full cross section and shall extend to full depth, width, and length. All expansion joint material extruding after the concrete is finished shall be trimmed as directed.

In the event the locations are not shown on the plans, joints shall be placed between all edges of the median or island pavement and the surrounding curb or pavement. Where applicable, joints shall be placed to match expansion and contraction joints in adjacent curb or pavement.

616.03.6--Protection and Curing. After the pavement is finished, it shall be protected and cured in accordance with the requirements of Subsection 501.03.20 or by other approved method.

Placement, protection, and curing of concrete during cold and hot weather shall conform to the limitations, conditions and requirements of Subsection 804.03.16.

616.03.7--Manufacturing and Placing Bituminous Pavement. Hot mix asphalt pavement used in construction of median and island pavement shall be manufactured and placed in accordance with the requirements of Sections 401 and 403, except that approved modified methods of placement, shaping, and compacting will be permitted. The pavement shall consist of the layers and types shown on the plans. The surface of the finished pavement shall conform closely to the typical section indicated on the plans and shall not have irregularities which would prohibit complete surface drainage, including drainage over adjacent curb.

616.03.8--Cleaning Up. All surplus material shall be disposed of as directed, and the completed work and the site shall be left in a neat and presentable condition.

616.03.9--Markings. When specified, pavement markings on median and island pavement shall be made as detailed or as directed by the Engineer, and shall conform to the provisions and requirements of the applicable sections for the

markings specified.

616.04--Method of Measurement. Median and island pavement of the type specified will be measured in square yards.

Excavation will not be measured for separate payment, and the cost thereof is to be included in the price of other items of work.

Pavement markings, if required, will be measured and paid for in accordance with the applicable sections for the markings specified.

616.05--Basis of Payment. Median and island pavement of the type specified will be paid for at the contract unit price per square yard, which shall be full compensation for completing the work.

Payment will be made under:

616-A: Concrete Median and/or Island Pavement, Thickness - per square yard

616-B: Bituminous Median and/or Island Pavement, Thickness - per square yard

SECTION 617 - RIGHT-OF-WAY MARKERS

617.01--Description. This work consists of furnishing and placing right-of-way markers in accordance with the plans and these specifications and at points designated on the plans, or as directed. The work also shall include the removal of right-of-way markers from their original locations and resetting at new locations as specified or established.

617.02--Materials. The materials used in this construction shall conform to the requirements of Subsection 706.04 or as indicated on the plans.

617.03--Construction Requirements.

617.03.1--General. Markers shall be manufactured in accordance with the details shown on the plans, and the requirements of this section.

Any required reinforcement shall conform to the details shown on the plans and the requirements of Section 602.

All letters, symbols, and other markings shall be as shown on the plans and shall be neatly imprinted in the markers.

The markers shall be set at the locations designated on the plans, or as directed by the Engineer. They shall be set to within 1/4 inch of the lines indicated or

established, even with the natural ground elevation, and in a vertical position within a tolerance of 1/8 inch per foot. Any required backfilling shall be made with suitable material thoroughly tamped in six-inch layers. All surplus material shall be disposed of as directed and the site shall be left in a neat and presentable condition.

The layout and placement of right-of-way markers shall be performed by, or under the supervision of, or directed by, a Registered Professional Engineer or Registered Land Surveyor who is duly registered and entitled to practice as a Land Surveyor in the State of Mississippi. The duties performed by said Registrant shall conform to the definitions under the practice of “land surveying” in Mississippi Law. The location of the markers shall be as shown in the plans, and as required to meet the minimum standards of surveying. The Contractor shall not engage the services of any person in the employ of the Department for the performance of any of the work covered by this Section or any person who has been employed by the Department within the past six months, except those who have legitimately retired from service with the Department during this period.

617.03.2--Removal and Resetting. Markers which are specified to be removed and reset shall be carefully removed and reset at the location indicated or established in accordance with the provisions and requirements of Subsection 617.03.1.

The Contractor shall replace without additional compensation all markers broken or damaged due to the removal and resetting operation.

617.04--Method of Measurement. Right-of-way markers, new and removed and reset, will be measured by the unit.

617.05--Basis of Payment. Right-of-way markers, new and removed and reset, will be paid for at the contract unit price per each, which shall be full compensation for completing the work.

Payment will be made under:

- 617-A: Right-of-Way Markers, Type _____ - per each
- 617-B: Right-of-Way Markers Removed and Reset - per each

**SECTION 618 - MAINTENANCE OF TRAFFIC AND
TRAFFIC CONTROL PLAN**

618.01--Description.

618.01.1--General. This work consists of maintaining two-way through and local traffic at all times, except as provided herein or in other contract documents. It consists of constructing, maintaining in good condition, and removing temporary structures, approach roads, and other facilities required for maintenance of traffic and the furnishing of temporary materials therefore, unless otherwise indicated in the contract.

This work includes furnishing, erecting, maintaining in good condition, and removing all required construction signs, barricades, and temporary traffic stripe.

When specified on the plans, the Contractor will construct, maintain and remove all detour bridges as indicated in the plans and contract documents. This work shall consist of the furnishing of materials, construction, maintenance and removal of bridges with payment as described hereinafter.

Unless shown otherwise in the plans, through and local traffic shall be maintained throughout the project at all times on existing facility, detours and completed permanent facility indicated on the plans and as necessary to carry out construction within the intent of the plans and contract. Minimum requirements of the Traffic Control Plan are shown on the plans.

Upon receipt of the Final or Partial Maintenance Release, as documented in writing by the State Construction Engineer, the Contractor shall have fifteen (15) calendar days in which to remove all construction signs on the project. It is agreed that if the signs are not removed within the fifteen (15) calendar days the signs shall be considered abandoned and shall become the property of the Mississippi Transportation Commission which may remove, use, and/or dispose of such signs as it sees fit.

The Contractor shall place and maintain appropriate construction signs for any additional work on the project after the Maintenance Release, or Partial Maintenance Release, has been issued. These construction signs will not be measured for separate payment. Payment for these signs shall be included in pay item no. 618-A, Maintenance of Traffic.

618.01.2--Traffic Control Plan. This work also consists of complying with the contract requirements of the Department's Traffic Control Plan. The purpose of the Traffic Control Plan is to maintain through and local traffic safely through construction zones. In addition to this section, the plan includes: Subsections 104.04, 105.15, 107.07, and 107.10; Section 619; special provisions modifying this section and supplements thereto; individual plan sheets applicable to the plan; and Part VI of the Manual on Uniform Traffic Control Devices (MUTCD). All traffic control devices shall comply with Part VI of the latest edition of the MUTCD.

The Department will designate a responsible person at the project level to monitor the Contractor's compliance with the plan.

The Contractor shall also designate a responsible person whose primary duty shall be to monitor and maintain the effectiveness of the plan. The Engineer shall be furnished with the telephone numbers where the Contractor's responsible person and a substitute, authorized to act in the absence of the responsible person, may be reached at all times when not on the project. This in no way modifies the requirements of Subsection 105.05 regarding the assignment and availability of the superintendent.

The Engineer, or other appropriate personnel as required, will review and analyze accidents to determine if corrective action to the Traffic Control Plan is needed. In the event corrective action is indicated, the Contractor shall proceed immediately with same.

The location and spacing of signs shown on the traffic control plan are approximate and, with approval of the Engineer, may be adjusted as necessary to fit field conditions.

Because of the required work at the beginning and end of a project, it may be necessary to erect construction signs or lane closure signs outside the limits of the project.

618.02--Materials. Unless otherwise specified, the Contractor shall provide all materials for the construction and maintenance of detours required for the maintenance of traffic, except the Engineer may permit the Contractor to use excavation from the roadbed, or other designated sources, that is available at the time of construction of detours without detriment to the work and provided the excavation is ultimately placed in its final position in the roadbed in an uncontaminated condition. No additional compensation will be made to the Contractor for the extra handling of the material.

Unless otherwise specified, the applicable material requirements set out in the Division 700 and in Section 619, or in other contract documents, shall apply to all materials used in temporary traffic facilities. The Contractor shall select and use materials that with adequate maintenance or replacement will provide a satisfactory facility for the entire period the temporary facility is required.

618.03-- Construction Requirements.

618.03.1--General. All detours shall be constructed and maintained in such a manner that they will adequately carry the traffic required.

Requirements for temporary traffic facilities shown on the plans, or set forth in these specifications, shall be understood to be the minimum requirements anticipated. Actual traffic conditions may require work or devices in addition to

those shown on the plans.

Traffic lanes shall be kept free of dust and, when deemed necessary, they shall be sprinkled with water, or some other dust palliative shall be applied.

Unless otherwise specified, temporary structures and roads shall be sufficiently strong to safely carry the load permitted on the highway under construction. Structures shall be provided with suitable curbs, rails, or other devices as required for the protection of traffic. Unless otherwise specified, walkways when required for pedestrians shall have a clear width of four feet, or as shown on the plans, and shall be protected from vehicular traffic in the manner specified or directed.

Unless otherwise specified, the Contractor shall remove all temporary detours, satisfactorily dispose of all surplus materials, grade, finish, and dress the disturbed areas to the required section, and complete all work incidental thereto prior to release of maintenance.

618.03.2--Barricades, Signs, and Flaggers. The Contractor shall construct, erect, maintain, clean, repair and replace as necessary all barricades, warning signs and other devices specified or ordered.

Flaggers shall be stationed at such points as may be deemed necessary. Movable construction signs shall be removed as their use becomes inapplicable. Placing temporary signs and their supports face down adjacent to the roadway will not be allowed.

The plans will usually contain a line diagram indicating the designation and location of construction signs which are to remain fixed in place for the duration of the maintenance period of the contract.

Such signs and all other signs and devices of a temporary nature shall be in accordance with Section 619, the plans, and the MUTCD, as applicable.

618.03.3--Safe Movement of Traffic. The Contractor shall limit construction operations to such length as necessary to meet the traffic handling requirements of the contract.

On two-lane roadways, traffic may be alternately routed over a single lane in such a manner as to provide safe movement of the traffic with minimum delay. In such case, flaggers will be required and, when deemed necessary, an approved pilot vehicle with sign meeting the requirements of the plan standards shall be provided and operated to control the speed and sequence of movement of the traffic.

A longitudinal pavement edge that traffic is expected to move across should have

an elevation difference of not more than $2\frac{1}{4}$ inches. If the pavement edge is more than $1\frac{1}{2}$ inches and less than or equal to $2\frac{1}{4}$ inches, uneven pavement signs will be required as shown in the plans or contract documents. If the pavement edge is less than or equal to $1\frac{1}{2}$ inches, no uneven pavement signs will be required. Transverse pavement joints shall be sufficiently tapered to allow for the safe movement of traffic.

When a paving operation produces a longitudinal pavement edge that traffic is expected to move across, the adjacent lane shall be constructed to eliminate any uneven pavement edge within 48 hours, unless prohibited by weather conditions or an emergency arises.

All failed areas that have been removed and all trenches shall be filled and compacted to the elevation of the existing pavement before work is discontinued for the day. In emergencies, the Engineer may permit the use of approved temporary materials for backfill, provided the temporary materials will be adequate to facilitate normal safe movement of traffic. Separate measurement for payment will not be made for the furnishing, placing, maintaining, removing, and disposing of such temporary materials.

Except under the following conditions, no portion of the roadway which is intended to be used for maintenance of traffic shall be blocked after work hours. In exceptional cases when all efforts have been made to restore the surface of the roadway and because of equipment failure or other uncontrollable causes complete restoration is not possible before work must be discontinued for that day, the Contractor shall provide adequate warning signals, barricades, other appropriate devices, and flaggers, appropriately placed or stationed for the protection of the public. The Engineer may also require the use of a pilot vehicle as provided herein.

The Contractor shall be required to place granular material on the shoulders at any time a differential of two and one-quarter ($2\frac{1}{4}$) inches or more exists between the present pavement edge and the shoulder grade. This condition may exist prior to any preliminary leveling, after the placement of the preliminary leveling, after the placement of the surface course. In any event, whenever or wherever, a $2\frac{1}{4}$ -inch differential exists between the pavement edge and the shoulder material, this condition shall be corrected by the placement of the shoulder material to correct the differential.

All centerline, lane lines, edge lines and no-passing stripes that have been covered or removed during the day's operations shall be replaced with temporary stripe before work is discontinued for the day or as soon thereafter as weather conditions will permit, except that:

- (1) Replacement of no-passing stripes may be delayed for a period not to exceed three (3) days for a two or three lane road.

- (2) Temporary edge lines may be eliminated on projects requiring shoulders constructed of granular material.
- (3) Temporary edge lines placed on the final pavement course of projects requiring paved shoulders without surface treatment shall be placed in the permanent stripe location, otherwise temporary edge lines on projects requiring paved shoulders may be placed on the adjacent shoulder in as near the permanent location as possible.

Temporary no-passing stripe is not considered a major item of work and such stripe which is eliminated because of placing the next course prior to expiration of the 3-day period shall not result in a monetary adjustment to the Contractor as provided in Subsection 104.02. All temporary stripe shall be placed in accordance with the plans and Subsection 619.03.2.

In addition to the temporary no-passing stripe, the Contractor shall erect standard "DO NOT PASS," "NO-PASSING ZONE," and "PASS WITH CARE" signs in accordance with plan details or as specified in the MUTCD. These signs shall be erected prior to the obliteration of the no-passing stripe and shall be maintained in good order until the Engineer permits their removal.

Permanent pavement markings are to be applied no sooner than 10 days nor later than 45 days after placement of the pavement. When shoulder paving or placement of granular material adjacent to the pavement edge is required and upon approval of the Engineer, the permanent edge stripe may be delayed until a section, not to exceed five miles, of the shoulder work is complete. When the project length is less than five miles, the edge stripe shall be placed no later than 15 days after completion of the adjacent shoulder.

Permanent pavement markings on surface treatment shall be delayed until the maximum amount of seal aggregate has embedded and all loose material is broomed from the surface. All temporary stripe shall be maintained in good order until placement of the permanent pavement markings or placement of the next pavement course or until removed. Maintenance of temporary stripe may require more than one application over the life of the project. Payment will be made for one application only.

618.03.4--Contractor's Responsibility. The Contractor shall be responsible for protection against loss or damage from any cause to all temporary structures including approaches, and shall maintain them in a satisfactory condition until their use is no longer required. If a temporary structure, or approaches, is damaged due to high water or other reasons, it shall be replaced by the Contractor at no additional cost to the State, except that for temporary structure and approaches constructed of materials and to the grades and sections indicated on the plans and in accordance with the applicable construction requirements of

the contract and adequately maintained, consideration will be given under the conditions and provisions of Subsection 107.17.

The Contractor shall maintain the surface of the existing facility and connections thereto on which the Contractor is required to maintain traffic. Such maintenance shall be in accordance with the provisions of Subsections 104.04 and 105.14 and other applicable requirements and shall be subject to the provisions of Subsection 105.15. All costs for such maintenance and surface repairs shall be included in the contract price bid for Maintenance of Traffic. Repair of structural failures in the pavement foundation, or a structure beneath the surface not resulting from the Contractor's failure to comply with the requirements or limitations of the contract, or from the Contractor's operations, will be the responsibility of the Department. The Department may, however, at its discretion require the Contractor to make repairs and will pay for them at the contract unit prices for the items and quantities of work involved or as Extra Work.

618.04--Method of Measurement. This work will be measured as a unit lump sum quantity consisting of continuous maintenance and protective services. The percentages of the contract lump sum price allowed on progress estimates will be determined by the percentage of the combined total monetary value of all direct bid items, excluding those items identified in the bid schedule as dependent items, earned during the current (same) estimate period. However, when the construction and traffic control signs have been erected the Contractor will be allowed payment at least equal to the value of the signs as computed at the fixed price for additional construction signs included in the contract.

For contracts containing pay items for individual traffic control devices, measurement of these items will be in accordance with Subsection 619.04.

In the event the Engineer determines that actual field and traffic conditions require fixed-in-place signs in addition to those shown on the line diagram of the plans, they shall be furnished, erected, and maintained, and measurement of these signs will be made by the square foot.

Construction and removal of detour bridges will be measured as a lump sum quantity, consisting of furnishing all labor and materials, construction, repair and replacement as deemed necessary during the life of the project and removal as follows:

After the permanent bridge is opened to traffic, the detour bridge shall be removed. All Contractor furnished material shall remain the property of the Contractor and shall be removed from the site.

Percentages for construction and removal of each detour bridge commensurate with the magnitude of the work will be applied as follows:

Construction of Detour Bridge	80%
Removal of Detour Bridge	20%

Each month the Engineer will estimate the percentage of construction and removal of each detour bridge and apply the percentage as indicated herein.

618.05--Basis of Payment. Maintenance of traffic, will be paid for at the contract lump sum price which will also include compensation for complying with the requirements of the Traffic Control Plan.

Individual traffic control devices that are included in the contract as pay items will be paid for in accordance with Subsection 619.05.

For contracts not containing pay items for individual traffic control devices, additional construction signs ordered by the Engineer will be paid for at the fixed contract unit price indicated in the bid schedule.

Construction and removal of detour bridges, measured as provided in Subsection 618.04, will be paid for at the contract lump sum bid price bid, which price shall be full compensation for furnishing all labor and materials, construction, repair, replacement and removal when ordered by the Engineer.

Additional maintenance responsibilities covering maintenance of the embankment, base and paving on detour roads will be measured and paid for as set out in Section 618.

These prices shall be full compensation for completing the work.

Payment will be made under:

- 618-A: Maintenance of Traffic - lump sum
- 618-B: Additional Construction Signs - per square foot
- 618-C: Construction and Removal of Detour Bridge - lump sum

SECTION 619 - TRAFFIC CONTROL FOR CONSTRUCTION ZONES

619.01--Description. This work consists of furnishing, placing, maintaining or replacing as necessary, removing when no longer applicable and installation at other locations all traffic control devices including pavement marking materials (paint, tape, markers, etc.) in accordance with contract provisions and as directed by the Engineer.

619.02--Materials. Certification of traffic control devices shall be in accordance with the provisions of Subsection 619.02.13.

619.02.1--Painted Traffic Stripe. Painted traffic stripe shall meet the applicable requirements of Sections 710 and 720.

619.02.2--Pavement Marking Tape. Preformed pavement marking materials must be listed on the Department's "Approved Sources of Materials" and meet the requirements of Subsection 720.05.

619.02.3--Reflective Raised Pavement Markers. Raised pavement markers must be on the Department's "Approved Sources of Materials" and shall meet the applicable requirements of Subsection 720.03.

619.02.4--Construction Signs. Construction signs shall meet the applicable requirements of Sections 618 and 721 and the following:

Sign supports may be steel beams, structural steel pipe, steel U-section posts, 4-inch x 4-inch wood posts, portable easels, or barricades as required for installation. Breakaway bases shall be provided for all steel beams and pipe posts. Portable sign supports may be used for daylight operations, moving work areas, or other short-term activities. Standards for height of construction signs shall be those shown for roadside signs in Chapter 6F of the Manual of Uniform Traffic Control Devices (MUTCD). Signs mounted on portable supports or barricades may be at lower heights but the bottom of the sign shall be no less than one foot above the traveled way.

Unless specified otherwise, fluorescent orange reflective sheeting, meeting the requirements of Subsection 721.06, shall be used on all construction signs regardless of whether used during daytime or nighttime hours.

Unless otherwise specified on the plans, the material on which the reflective sheeting is to be applied shall be as a minimum, 16-gauge steel, 0.080-inch aluminum, or 5/8-inch high density overlaid plywood. Ungalvanized steel, exterior grade plywood and lumber shall have a minimum of two coats of paint on front, back, and edges. High density overlaid plywood shall have the edges painted. The material to which reflective sheeting is to be applied shall be prepared in accordance with the recommendations of the sheeting manufacturer.

For new signs, the Contractor shall furnish the Engineer with three certified copies of a statement or test report from the producer indicating that the signs meet the requirements of the specifications.

Previously used signs will be accepted on the basis of reflectivity and legibility. Reflectivity for these signs may be tested by the Engineer in accordance with the procedures set out below or by the Central Laboratory in Jackson. If tested by the Central Laboratory, the reflective sheeting shall have at least 50 percent of the reflectivity specified for new sheeting. Tests performed in the Central Laboratory will be for reflectance only, and the Contractor shall pay the testing

charges. Legibility in all cases will be determined by the Engineer.

The determination for reflectivity and legibility by the Engineer will be made from the drivers seat of an automobile with the headlamps on low beam between the hours of one hour after sunset and one hour before sunrise at the distance specified below. The signs shall be mounted at the specified height for each type sign as it is being tested. Should the Contractor elect to have the signs tested in place, each sign not meeting the requirements of these specifications shall be immediately removed and replaced. The Engineer will certify by letter to the State Materials Engineer that the signs have been tested and accepted under this procedure.

A sign will be considered as meeting the reflectivity requirements of this specification when the shape and color of the sign can be unquestionably identified at a distance of 1500 feet from the sign. In cases where grade or alignment will not permit a sight distance of 1500 feet, the distance for specification compliance shall be the furthestmost point at which the complete sign becomes visible.

If there is a question as to a sign being acceptable, the sign may be sent to the Central Laboratory for verification. Testing charges will be borne by the State when the verification test determines that the sign is acceptable.

Legibility will be acceptable when the sign letters and numerals are capable of being read at a distance determined by the following formula:

$$D = 50 H$$

D = Distance in Feet

H = Letter/numeral height in inches

619.02.5--Advance Warning Flashing Arrow Panels. Flashing arrow panels shall meet the requirements of Section 6F.53 of the MUTCD.

619.02.6--Median Barrier and Delineators. Precast concrete median barrier shall meet the requirements of the plans, contract documents, and Section 615 except the surface may be a Class 1 ordinary surface finish unless designated otherwise. When precast concrete median barriers are no longer needed at one location, as determined by the Engineer, the barriers shall be removed and reset at other designated locations. When barriers have to be stored until needed at another location, payment for removing and resetting will not be made until they are reset at their designated location. The Contractor shall furnish the storage area.

The Engineer may allow the installation of used barriers for temporary traffic control upon an inspection and determination that the barrier units are structurally adequate for their intended purpose and they meet the requirements

of the Section. Barriers with small chips or fractures not affecting their integrity may be accepted.

Precast concrete barriers used on construction projects which were purchased or manufactured after October 1, 2002 must meet the requirements of NCHRP Report 350. Precast median barriers purchased or manufactured prior to October 1, 2002 may be used until they complete their normal service life.

Certification of precast concrete barriers shall be as required in Subsection 619.02.13.

Portable median barrier shall be a highly portable, crashworthy barrier especially designed and used as a temporary barrier on highway construction projects. The barriers shall be designed so that it can be filled with water when in use and be easily drained for moving and transporting. The barrier shall be National Cooperative Highway Research Program Project (NCHRP) Report 350 approved for the speed rating indicated on the plans or in the contract documents.

The Contractor shall furnish the Engineer three copies of the manufacturer's certification stating that the portable median barriers furnished meets the requirements of this Section.

Delineators shall be listed on the Department's "Approved Sources of Materials" and meet the requirements of the plans and Section 6F.68 of the MUTCD.

619.02.7--Channelization Devices, Barricades, and Warning Lights. Channelization devices, vertical panels, tubular markers, cones, drums, barricades and temporary raised islands shall meet the requirements of the plans and Sections 6F.55 through 6F.64 of the MUTCD. Drums shall be constructed of lightweight, deformable material capable of retaining reflective sheeting. Reflective sheeting for drums shall be Type III meeting the requirements of Subsection 721.06. Warning lights shall meet the requirements of Section 6F.72 of the MUTCD.

619.02.8--Traffic Signals and Flashers. Traffic signals and flashers shall meet the requirements of the plans and Section 6F.71 & 6F.74 of the MUTCD.

619.02.9--Impact Attenuators. Impact attenuators must be listed on the Department's "Approved Sources of Materials".

Replacement Packages. Replacement packages shall consist of spare parts of the expected type and number needed to repair one hit for every three attenuators in place.

619.02.10--Temporary Guardrail. Temporary guardrail shall meet the requirements of the plans and the applicable requirements of Sections 606 and

712.

619.02.11--Snap-Back Delineators. Snap-back delineators shall be selected from the list of surface mounted flexible delineator posts as shown on the Department's "Approved Sources of Materials".

619.02.12--Terminal End Section. Terminal end sections, installed as per manufacturer's recommendations, shall be National Cooperative Highway Research Program (NCHRP) Report 350 Test Level 3 (TL-3) approved. When specified in the plans, the terminal end sections shall be the type specified, unless otherwise approved by the Engineer.

The Contractor shall furnish the Project Engineer two (2) copies of the manufacturer's installation instructions prior to beginning guard rail operations.

619.02.13--Certification of Traffic Control Devices. The Contractor will be required to certify that the traffic control devices used on the project meets certain requirements. The traffic control devices shall be certified in accordance with the following requires:

Category 1 Traffic Control Devices. Category 1 traffic control devices are defined as low-mass, single-piece traffic cones, tubular markers, single-piece drums, and delineators.

The Contractor shall certify to the Project Engineer by a letter ONLY stating that the Category 1 traffic control devices, furnished and used, either meet the requirements of NCHRP Report 350 or were purchased prior to October 1, 1998.

All documentation supporting the certification is to be kept on file by the Contractor subject to review by the Department at any time. Support documentation shall be kept on file for two years after the completion of the project.

The Contractor may self-certify Category 1 Traffic Control Devices. In order to make the self-certification, the Contractor shall have as a minimum the following support documentation regarding the certification.

1. A title, e.g., "Certification of Crashworthiness";
2. Name and address of vendor making the certification;
3. Unique identification of the certificate such as serial number, with numbered pages and the total number of pages;
4. Description and unambiguous identification of the item tested;
5. Identification of the basis for self-certification process used and to what test level of NCHRP Report 350. This basis as crash test experience with similar devices or years of demonstrably safe operational performance;
6. A signature and title, or an equivalent identification of the person(s)

accepting responsibility for the content of the certification, however produced, and the date of issue;

7. A statement that the certification shall not be reproduced except in full.

All documentation supporting the self-certification is to be kept on file by the Contractor subject to review by the Department at any time. Support documentation shall be kept on file for two years after the completion of the project.

The Contractor's letter to the Project Engineer shall state that all Category 1 traffic control devices, furnished and used, were purchased after October 1, 1998 and met the requirements of NCHRP Report 350, or that the Category 1 traffic control devices, furnished and used, were purchased prior to October 1, 1998.

Category 2 Traffic Control Devices. Category 2 traffic control devices are defined as barricades, intrusion detectors, vertical panel assemblies, portable sign supports, drums with warning lights, and cones with warning lights.

The Contractor shall certify to the Project Engineer by a letter ONLY stating that the Category 2 traffic control devices, furnished and used, either meet the requirements of NCHRP Report 350 or were purchased prior to October 1, 2000. The Contractor's letter shall state that all Category 2 traffic control devices, furnished and used, were purchased after October 1, 2000 and met the requirements of NCHRP Report 350, or that the Category 2 traffic control devices, furnished and used, were purchased prior to October 1, 2000.

Category 3 Traffic Control Devices. Category 3 Traffic Control Devices are items similar to Category 2 but weigh more than 100 pounds. Category 3 Traffic Control Devices include concrete barrier, truck mounted attenuators (TMAs), workzone crash cushions, and fixed sign supports.

Concrete barrier and fixed sign supports, furnished and used, and purchased after October 1, 2002 must meet the requirements of Report 350.

The Contractor shall furnish a letter ONLY certifying that all concrete barrier and fixed sign supports purchased after October 1, 2002 meets the requirements of NCHRP Report 350. Concrete barrier and fixed sign supports purchased prior to October 1, 2002 may be used without written certification until they complete their normal service life.

Work zone crash cushions and truck mounted attenuators (TMAs), furnished and used, and purchased after October 1, 1998 must meet the requirements of Report 350.

The Contractor shall furnish a letter certifying that all work zone crash cushions and TMAs purchased after October 1, 1998 meets the requirements of NCHRP

Report 350. Work zone crash cushions and TMAs purchased prior to October 1, 1998 may be used without written certification until they complete their normal service life.

Contractor's Letter to the Project Engineer. The following is an example of a letter to the Project Engineer.

"I, (Contractor's name), certify that the Category 1 traffic control devices used on this project and purchased after October 1, 1998 meet the requirements of NCHRP Report 350 and all Category 1 traffic control devices used on this project not meeting NCHRP Report 350 were purchased prior to October 1, 1998.

I also certify that the Category 2 traffic control devices used on this project and purchased after October 1, 2000 meet the requirements on NCHRP Report 350 and all Category 2 traffic control devices used on this project not meeting NCHRP Report 350 were purchased prior to October 1, 2000.

I also certify that except for concrete median barrier, all of the Category 3 traffic control devices crash cushions and truck mounted attenuators used on this project and purchased after October 1, 1998 meet the requirements on NCHRP Report 350 and all Category 3 crash cushions and truck mounted attenuators used on this project not meeting NCHRP Report 350 were purchased prior to October 1, 1998."

619.03--Construction Requirements.

619.03.1--General. Traffic control devices shall be furnished and utilized in accordance with the Traffic Control Plan (TCP), reference Section 618. Upon failure of the Contractor to adequately maintain traffic control devices and safe movement of traffic through the construction zones, the provisions of Subsection 105.15 will be invoked.

619.03.2--Temporary Stripe. Temporary stripes are pavement markings, temporary in nature, such as those used to direct traffic from it's customary path or those to be removed from the pavement course under use for further temporary traffic control or those to be covered by the next pavement course and/or those to be replaced by permanent stripes. Temporary stripes shall be 4-inch paint or preformed tape as designated on the plans or when not designated, the use of paint or tape will be at the Contractor's option. Temporary stripes on surface treatments shall be paint.

All temporary stripe shall be placed in accordance with the plans and the requirements set out in Section 625, except that alignment of temporary stripe placed on underlying courses shall have a tolerance of four inches in fifty (50) feet from true alignment for skip stripes and edge lines and one inch in fifty (50)

feet from true alignment for no-passing stripes and lane lines. When preformed tape is used on the final pavement course for temporary traffic markings, it shall be removed at no additional cost to the State.

Temporary paint stripe requiring removal shall be removed by carefully controlled blast cleaning, approved grinding or other approved methods in such a manner that the surface to which the stripe was applied will not be unnecessarily marred or damaged. Preformed tape is to be removed in accordance with the manufacturer's recommendations.

Temporary paint stripe which has been placed on the final pavement course may be left in place and covered with permanent stripe of the same color provided the temporary stripe has been satisfactorily placed in the proper location. Under this condition, any remaining temporary paint stripe not covered by the permanent stripe shall be removed at no additional cost to the State.

Painted traffic stripe which has been removed from the final asphalt pavement surface shall be sealed with an approved sealant. The Engineer may wave the sealant requirement when the area to be sealed is insignificant. This sealing operation shall be performed at no additional costs to the State.

All temporary pavement markings placed and measured for payment under this section shall include any required removal. Removal of all temporary stripe will not be measured for separate payment.

Existing pavement markings conflicting with temporary markings shall be removed. Removal of such materials (paint, tape, marker, etc.) will be measured and payment made under Section 202. When measuring removal of pavement markings for payment, the skips will not be included in the measurement.

619.03.3--Blank.

619.03.4--Reflective Pavement Markers. Reflective pavement markers for construction zones shall be secured to the pavement by an approved adhesive. The portion of the highway surface to which the marker is to be bonded shall be free of dirt, grease, oil, moisture, loose or unsound layers and any other material which would adversely affect the bond of the adhesive. Clean pavement need not be blast-cleaned unless the surface contains an abnormal amount of asphalt or the surface is contaminated with dirt, grease, oil, or any other material that would adversely affect the bond of the adhesive. Necessary cleaning shall be performed by blast cleaning.

When a pressure-sensitive pad is used, a primer shall be applied directly to the road surface with a brush or sprayer but is not to be applied when the ambient temperature is lower than 50°F. No marker shall be installed when the relative humidity of the air is greater than 80 percent or when the pavement is not surface

dry. Traffic shall not be permitted to run over the primed area until after the markers have been installed. After priming, allow one minute for the primer to dry, then peel the release paper from the pressure-sensitive pad and immediately place the marker in the correct position on the primed road surface and apply light pressure. Drive slowly over the located marker with one wheel of a truck to help set it in place. Traffic may be allowed immediately.

All markers shall be installed in a uniform line, with controls established by the Engineer. The Engineer will establish controls for each line of markers by setting control points at not less than approximately 600-foot intervals on tangents and 50-foot intervals in curves. All additional work necessary to establish intermediate control points and individual marker points shall be performed by the Contractor. On curves, the line of markers on lane lines and edge lines shall follow the normal curvature of the curve and placement on chords or other variations from the normal curvature will not be permitted, unless specifically shown on the plans or ordered by the Engineer.

Reflective markers shall be installed in such a manner that the reflective face of the marker is perpendicular to a line parallel to the roadway centerline. No markers shall be installed over longitudinal or transverse joints of the pavement surface.

All markers placed out of alignment shall be removed and replaced by a new marker.

619.03.5--Impact Attenuators. Impact attenuators shall be installed and maintained by experienced workmen familiar with the installation of impact attenuators. Installation shall be in accordance with the recommendations of the manufacturer. Each impact attenuator shall also include one replacement package. A replacement package shall consist of the quantity of materials necessary to repair one hit for every three attenuators in place. The Contractor shall use these parts to maintain the attenuator during the construction period. When it becomes necessary to install a replacement package, the Contractor shall order an additional replacement package to have available for future use. All unused parts and the attenuators shall become the property of the Contractor upon completion of the project.

619.03.6--Temporary Guardrail. Temporary guardrail shall be installed in accordance with the plans and the applicable provisions of Section 606.

The sites where temporary guardrail has been removed shall be restored to their original condition or to an improved condition if part of the contract.

Salvage of temporary guardrail designated to become the property of the Department shall be in accordance with Subsection 202.03.

619.03.7--Maintenance of Traffic Signs. All signs whether placed new or previously used shall meet the requirements of this specification on each inspection. Signs failing to comply with these requirements shall be replaced at no additional cost to the State.

619.03.8--Snap-Back Delineators. Snap-back delineators shall be installed in accordance with the manufacturer's recommendations and at the locations shown on the plans or directed by the Engineer. Delineators that are damaged by traffic to the extent that they are non-functional shall be replaced as quickly as possible.

619.03.9--Portable Median Barrier. Portable median barriers shall be installed in accordance with the manufacturer's recommendations. The barriers shall be installed at the locations shown on the plans, or as directed by the Engineer.

619.04--Method of Measurement. Traffic control devices will be measured one time only by the units indicated and when moved from the original location to other locations as required by the contract or as directed by the Engineer will not be measured for additional payment except when the contract includes the pay item, "Remove and Reset." The total pay quantity for each traffic control device excluding traffic stripe shall not exceed the maximum number of installations in place at any given time during the life of the contract. Unless otherwise provided for, replacement of devices will not be measured for payment.

The unit price for each type and color of detail striping shall be based on striping a width of six inches. When striping of a width greater than six inches is specified in the contract, or ordered, the measured length of striping will be converted to an equivalent length of six-inch width.

Temporary stripe, completed and removed in accordance with the requirements of this Section, will be measured by the mile or by the linear foot, as indicated, from end-to-end of individual stripes. In the case of skip lines the measurement will include skips. The length used to measure centerline, lane lines and edge stripes will be the horizontal length computed along the stationed control line. Detail traffic stripe will be measured by the linear foot from end-to-end of individual stripes. Measurement will be made along the surface of each stripe and will exclude nominal skip intervals where specified. Stripes more than four inches in width will be converted to equivalent lengths of four-inch stripe.

Legend, which is to include railroad markings, pedestrian crosswalks and stop lines, will be measured by the square foot or linear foot. Pay areas of individual letters and symbols will usually be shown on the plans and measured by the square foot. Transverse railroad bands, pedestrian crosswalks and stop lines will generally be measured by the linear foot, in which case, stripes more than four inches in width will be converted to equivalent lengths of four-inch widths.

Each impact attenuator installation, including one replacement package, will be

measured by the unit for each installation as shown on the plans. Replacement packages, excluding the package included with the initial attenuator, will be measured by the unit in accordance with these specifications.

Initial snap-back delineators will be measured by the unit. Replacement will be measured as follows:

- (a) Replace reflective material measured as 1/4 unit.
- (b) Replace complete tube measured as 1/3 unit.
- (c) Replace shock cord adapter measured as 1/3 unit.

619.05--Basis of Payment. Traffic control devices will be paid for at the contract unit price for the units specified. Devices that have been measured for payment and subsequently require repair or replacement will be dropped from payment on future estimates unless satisfactorily repaired or replaced.

Payment for devices for which no pay items are contained in the contract will be included in the unit prices of contract items and/or in the lump sum contract price for Maintenance of Traffic.

The prices thus paid shall be full compensation for completing the work.

Payment will be made under:

619-A1:	Temporary Traffic Stripe, Continuous White, <u>Description *</u>	- per linear foot or mile
619-A2:	Temporary Traffic Stripe, Continuous Yellow, <u>Description *</u>	- per linear foot or mile
619-A3:	Temporary Traffic Stripe, Skip White, <u>Description*</u>	- per linear foot or mile
619-A4:	Temporary Traffic Stripe, Skip Yellow, <u>Description*</u>	- per linear foot or mile
619-A5:	Temporary Traffic Stripe, Detail, <u>Description*</u>	- per linear foot
619-A6:	Temporary Traffic Stripe, Legend, <u>Description*</u>	- per square foot or linear foot
619-B:	Blank	
619-C1:	Red-Clear Reflective Raised Pavement Marker	- per each
619-C2:	Two-Way Yellow Reflective Raised Pavement Marker	- per each

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619-C3: One-Way Clear Reflective Raised Pavement Marker	- per each
619-C4: One-Way Yellow Reflective Raised Pavement Marker	- per each
619-C5: Yellow Clear Reflective Raised Pavement Marker	- per each
619-C6: Red-Clear Reflective High Performance Raised Marker	- per each
619-C7: Two-Way Yellow Reflective High Performance Raised Marker	- per each
619-C8: One-Way Clear Reflective High Performance Raised Marker	- per each
619-C9: One-Way Yellow Reflective High Performance Raised Marker	- per each
619-C10: Yellow Clear Reflective High Performance Raised Marker	- per each
619-D1: Standard Roadside Construction Signs, Less than 10 Square Feet	- per square foot
619-D2: Standard Roadside Construction Signs, 10 Square Feet or More	- per square foot
619-D3: Remove and Reset Signs, All Sizes	- per each
619-D4: Directional Signs	- per square foot
619-D5: Directional Signs, Overhead, <u>Location</u>	- lump sum
619-E1: Flashing Arrow Panel, Type _____	- per each
619-E2: Sequencing Chevron Panel, <u>Size</u>	- per each
619-F1: <u>**</u> Median Barrier, <u>***</u>	- per linear foot
619-F2: Remove and Reset <u>**</u> Median Barrier, <u>***</u>	- per linear foot
619-F3: Delineators, <u>Mounting</u> , <u>Description</u>	- per each
619-F4: Snap-Back Delineator	- per unit
619-F5: Snap-Back Delineator, Replacement	- per unit
619-G1: Blank	

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619-G2: Barricades, Type I	- per each
619-G3: Barricades, Type II	- per each
619-G4: Barricades, Type III, ****	- per linear foot
619-G5: Free Standing Plastic Drums	- per each
619-G6: Warning Lights, Type A	- per each
619-G7: Warning Lights, Type B	- per each
619-G8: Warning Lights, Type C	- per each
619-H1: Traffic Signals, <u>Location</u>	- lump sum
619-H2: Hazard Identification Beacons	- lump sum
619-J1: Impact Attenuator, <u>Speed Rating</u>	- per unit
619-J2: Impact Attenuator, <u>Speed Rating</u> , Replacement Package	- per unit
619-K1: Installation and Removal of Guardrail, Type____, Class____	- per linear foot
619-K2: Installation and Removal of Guardrail, Type____ Bridge End Section	- per each
619-K3: Installation and Removal of Guardrail, Type____ Cable Anchorage	- per each
619-K4: Installation and Removal of Guardrail, Terminal End Section	- per each

* The description for temporary traffic stripe will be shown as "paint" or "tape". In the case of "tape" the type will also be designated. When the description is not designated, the use of "paint" or "tape" will be at the Contractor's option.

** Indicate Concrete or Portable

*** Indicate Speed Rating, Color, etc. if applicable

**** Indicate if barricade is to remain with "Permanent"

SECTION 620 - MOBILIZATION AND REQUISITE WORK

620.01--Description. Mobilization consists of moving all labor, equipment,

supplies, and incidentals to the project site and removing same after other work under the contract has been completed. It also includes all mobilization pre-construction costs which are necessary direct costs to the project and are of a general nature rather than directly attributable to other pay items.

Requisite work consists of the preparation for and the performance of construction necessary as a requisite to the performance of other items of work and the cost of such work when no other provisions are made in the contract for payment therefore. Such work shall include, but is not limited to, all obligations, preparation, construction and all other costs of requisite work for which no compensation is provided in other items of work.

620.02--Blank.

620.03--Blank.

620.04--Method of Measurement.

620.04.1--Mobilization. Measurement for payment will be in accordance with the following schedule:

- (a) When one percent of the original contract amount is earned from other bid items exclusive of those listed as dependent items, 10 percent of the amount bid for mobilization, or one percent of the original contract amount, whichever is lesser, will be paid.
- (b) When five percent of the original contract amount is earned from other bid items exclusive of those listed as dependent items, 50 percent of the amount bid for mobilization, or five percent of the original contract amount, whichever is lesser, will be paid.
- (c) When 10 percent of the original contract amount is earned from other bid items exclusive of those listed as dependent items, 100 percent of the amount bid for mobilization, or 10 percent of the original contract amount, whichever is lesser, will be paid.
- (d) Upon completion of all work, payment of any amount bid for mobilization in excess of 10% of the original contract amount will be paid.

In the event the contract is terminated under the provisions of Subsection 108.09, the percentages listed will not be used in computing total payment, but the percentage of original contract amount, exclusive of dependent items, earned at the time of termination will be applied to the lump sum price bid for mobilization.

620.04.2--Requisite Work. For monthly estimates, the Engineer will estimate the percentage of requisite work completed. Upon satisfactory completion of all requisite work, measurement will be considered as 100 percent.

620.05--Basis of Payment. Mobilization and requisite work will be paid for at the contract lump sum prices, which shall be full compensation for completing the work. When not listed as pay items, the cost of this work shall be included in the prices for other items bid.

Payment will be made under:

620-A: Mobilization - lump sum

620-B: Requisite Work - lump sum

SECTION 621 - FIELD LABORATORY

621.01--Description. When required in the contract, this work consists of providing, for the exclusive use of the Engineer, one or more approved field laboratory buildings or portable trailers in which to house the equipment necessary to conduct required tests. It shall also include the furnishing of utilities as herein provided and the removal of the facilities after the work has been completed. Unless otherwise specified, the building or trailer will remain the property of the Contractor.

621.02--Blank.

621.03--Construction Requirements. Unless otherwise indicated in the contract, each field laboratory shall be at least seven and one-half feet wide, seven feet high inside, and shall contain at least 150 square feet of floor space. Each unit shall be floored, roofed, and weather-tight and shall contain the following:

- (a) At least three windows, each having at least six and one-half square feet of opening.
- (b) At least one door with lock and two keys.
- (c) A suitable work bench with adequate drawers.
- (d) Sink with running water supply as necessary for running tests.
- (e) Adequate ventilation and lighting, and facilities for providing reasonable temperature control.
- (f) Adequate supply of gas and electric current as required for testing.

In addition to the above, the Contractor shall provide toilet facilities within one

hundred feet of each field laboratory.

Each unit shall be located as specified, and in the case of central mixing or other plants, the unit shall be so located that the details of the Contractor's or producer's plant operations are in plain view of and visible from at least one window. Where the Contractor's operations are such that the Engineer deems it advisable to do so, the Contractor shall move the unit to other suitable location(s). The Engineer shall be the sole judge as to the number of laboratory units required.

621.04--Method of Measurement. Each specified field laboratory conforming to the requirements of the contract will be measured by the unit complete in place.

621.05--Basis of Payment. Field laboratories furnished as specified will be paid for at the contract unit price per each, which price shall be full compensation for all materials, equipment, tools, labor, utilities, and incidentals necessary to provide each unit, for moving the unit(s) to other suitable locations, and for removal from the work before final acceptance.

Payment will be made under:

621-A: Field Laboratory - per each

621-B: Field Laboratory, Per Plans - per each

SECTION 622 -- ENGINEER'S FIELD OFFICE BUILDING

622.01--Description. When required in the contract, this work shall consist of furnishing and maintaining a field office building for the exclusive use by the Engineer. The field office shall consist of a building, house, mobile office or trailer, approved by the Engineer, and in reasonably close conformity with these specifications.

When so indicated in the contract by pay item designation: LO (Laboratory and Office Building) this work shall also consist of the furnishing and maintaining of a combination field laboratory and field office building in reasonably close conformity with the requirements of these specifications.

In all cases where not specifically provided otherwise, this work shall also consist of furnishing appliances and utilities as herein provided, and the removal of the facilities after the work has been completed; it being understood that the building or trailer remains the property of the Contractor furnishing such facility.

622.02--Materials. All materials and appurtenances required shall be of good commercial quality, approved by the Engineer; however, sampling and testing

will not be required.

622.03--Construction Requirements.

622.03.1--Types of Field Office Buildings. Field office buildings shall be designated as Type 1, Type 2 or Type 3. Combination field laboratory and field office buildings shall be designated as Type 2 LO, or Type 3 LO.

622.03.1.1--Type 1, Type 2 and Type 3 Field Office Buildings. Type 1, Type 2 or Type 3 Field Office Buildings shall meet the following minimum requirements:

A. Dimensions. All measurements shown are clear inside dimensions as follows:

Building	Constructed on or for Project linear feet, minimum			Commercially Produced linear feet, minimum		
	Width	Length	Head-Room	Width	Length	Head-Room
Type 1	8.0	10.0	8.0	7.5	9.5	7.0
Type 2	10.0	30.0	8.0	9.5	29.5	7.0
Type 3	12.0	50.0	8.0	11.5	49.5	7.0

B. Doors and Windows.

1. Each building shall be provided with at least one standard height solid entrance door complete with lock and at least two keys. The opening shall also be provided with a self closing screen door. Type 3 Building shall have at least two such doors and screens.
2. Each wall, unless predominately occupied by a door shall be provided with at least one hinged, jalousied, or sliding window; glazed, screened and fitted with venetian blinds. Each window shall have an area of at least 6.5 square feet of opening, except toilet area which may be 3.25 square feet.

Type 1 Building shall have at least three windows.

Type 2 Building, at least six windows.

Type 3 Building, at least 10 windows.

C. Walls and Roof. If constructed on or for the project, walls and roof of all types shall be constructed with 2 x 4 studs and rafters.

1. Both sides of walls shall be covered with 3/8-inch thick plywood; exterior grade on the outside. No open cracks or knotholes will be

permitted. If commercially produced, standard wall construction will be accepted.

2. Roof: The roof shall be water tight and shall slope at least one inch in twelve inches (1:12) in one direction away from the door if practicable. It shall have at least 12-inch eaves. If commercially produced, an arched roof without eaves will be accepted.
3. At least 1¼-inch thick rock wool, fiber glass or other non-flammable insulating material shall be placed in the walls and ceiling. This material shall be in all wall and ceiling cavities not occupied by a door or window.

D. Ceiling. The ceiling on all types shall be covered on the inside of the roof rafters with 3/8" minimum thickness plywood if constructed on the project. Standard ceiling will be accepted if commercially produced.

E. Floor. The floor may be timber, a minimum of 12 inches above the ground on 2 x 6 joists. Open cracks, open knotholes, etc. will not be permitted.

F. Heater. The heater may be oil fired, gas or electric. Oil and gas units shall be properly vented to the outside, provided with adequate outside fuel storage and shall be connected thereto with suitable feed lines. Gas units may be connected to a commercial gas main, if available. The heater shall be capable of furnishing sufficient heat to maintain an inside temperature of 72 to 78°F.

G. Work Table, Desk, Chairs, Filing Cabinet, Plan Rack and Locker. Work tables shall be provided, with the tops measuring at least 3' 0" x 7' 6"; shall be stable and constructed with 3/4-inch plywood covered on top with smooth masonite. The height shall be approximately 3' 0" above the floor. One such table shall be provided for a Type 1 Building, 2 or more for a Type 2 Building, and 3 or more for a Type 3 Building. At the option of the Contractor, portable engineers' drafting tables of comparable size may be provided in lieu of the tables indicated hereinabove.

For Type 3 Buildings the Contractor shall also furnish one 30-inch x 60-inch minimum size office desk and swivel chair plus two straight chairs and shall also furnish a metal four-drawer vertical filing cabinet, one plan holder rack, one approved locker with separate lock and key for storing Engineer's instruments, two clothes lockers or closets, and one fire extinguisher.

H. Stools. Two stools of the proper height shall be furnished for each work site.

I. Miscellaneous Storage Shelves. Except for Type 3 buildings, six linear feet of storage shelves for books, etc., shall be furnished. If two 3-foot shelves are furnished, they shall be no less than 12 inches apart vertically. Type 3 Buildings

shall have six linear feet of shelves in each end.

J. Toilet Facilities. Type 2 and Type 3 Buildings shall have satisfactory indoor enclosed toilet facilities meeting the sanitary code of the local governmental agency having jurisdiction in the area where the unit is to be used. For Type 1 Buildings, the Contractor shall provide at the site of the building outdoor toilet facilities meeting the applicable sanitary code.

K. Utilities. All utilities, including water, sewage, gas and electricity, shall be connected to their service source ready for use prior to the Engineer's occupancy.

Water service shall be potable quality or a separate drinking water supply shall be furnished. Lighting shall be adequate to provide not less than 70-foot candles of light on all working surfaces. Not less than one electrical convenience outlet shall be provided for each desk and table plus two additional outlets each in the office space and laboratory space. Heating and cooling shall be thermostatically controlled. The Contractor shall have one telephone installed in the name of the Engineer.

The telephone service shall be capable of providing service to the Project Office, District Office, Contractor's Field or Main Office, and the Central Offices in Jackson.

The Contractor shall provide an all weather access road to the field office and laboratory and parking for not less than six full-sized automobiles.

For the duration of the contract, the Contractor shall maintain the field office and laboratory, shall provide janitor service at least once each week, and shall supply all heating fuel, electricity, water, and telephone service.

L. Air Conditioner. For Type 2 and Type 3 Buildings, an air conditioning unit shall be furnished and shall be capable of furnishing sufficient cooling to adequately maintain an inside temperature of 72 to 78°F.

622.03.1.2--Type 2 LO and Type 3 LO Field Office Buildings. Type 2 LO or Type 3 LO buildings shall meet the requirements specified hereinabove for Type 2 or Type 3, respectively, and in addition shall meet the following minimum requirements:

A. Dimensions. Type 2 LO buildings shall have dimensions not less than those specified for Type 2 above and, in addition, shall be partitioned into two rooms. One room for laboratory space shall consist of not less than 125 square feet floor space, shall consist of not less than 150 square feet floor space, including toilet, with the combined total floor space of not less than that specified for Type 2 above. Each Type 2 LO building shall have two entrance doors as described in Subsection 622.03.1.1, B, 1.

Type 3 LO Buildings shall have dimensions not less than those specified for Type 3 above, and, in addition, shall be partitioned into two rooms. One room for laboratory space shall consist of not less than 150 square feet of floor space and other room for office space shall consist of not less than 400 square feet of floor space, including toilet, with the combined total floor space of not less than that specified for Type 3 above.

Each LO building shall have a swinging or sliding door between the specified two rooms.

B. Construction and Facilities. Type 2 LO or Type 3 LO buildings shall be constructed, equipped and utilities provided as set out in Subsection 622.03.1.1, B through L, except that the portion indicated to be used as a field laboratory shall be modified to provide minimum laboratory facilities as specified in Subsection 621.03.

Heating and cooling facilities shall be such as to provide the temperatures specified in Subsection 622.03.1.1, F and L, in each room.

The Contractor may furnish larger buildings than the type specified, provided all inside arrangements meet minimum requirements and are approved by the Engineer.

When a Type 2 LO or Type 3 LO building is specified, the Contractor may furnish either a single building partitioned as indicated to provide the required space, or separate units, one in accordance with the construction details of Section 621 and the other in accordance with this Section 622 for Type 2 or Type 3, depending upon whether Type 2 LO or Type 3 LO is specified.

In case separate units are furnished, each shall be equipped, located and services provided as if each were specified.

622.03.2--Location. Engineer's field office building Type 1 shall be located within or near the project limits as directed by the Engineer. As the work progresses the offices shall be moved to other locations at the direction of the Engineer.

Types 2 and 3 office buildings and Types 2 and 3 LO buildings may be located within the project limits or near the project as directed by the Engineer. Whenever possible the building shall be located within 1,000 feet of a source of electric power provided by the Contractor and the Contractor shall provide such electric power to the building as indicated hereinabove. When the Engineer determines it is necessary to so locate the building that electric power must be transmitted for exclusive use by the Engineer for a distance in excess of 1,000 feet, the cost for that part of the distance in excess of 1,000 feet shall be

considered Extra Work.

622.03.3--Ownership and Use. Whether owned, leased or rented by the Contractor, possession of each building will remain with the Contractor who provides the building. The building(s) and all appurtenances shall be furnished, located and made ready for use by the Engineer as a first item of work. The building(s) shall be reserved for the exclusive use of the Engineering Personnel for such time as considered necessary, but no longer than the date of final release from maintenance on the project. The use, location, relocation and removal shall be under the direction and control of the Engineer and no portion of the building shall be occupied, or otherwise used by the Contractor, unless permitted by the Engineer in writing and subject to any provisions or limitations set forth in such written permission. When no longer needed, and upon specific instructions of the Engineer, each building shall be removed from the project.

622.04--Method of Measurement. Each specified Engineer's field office building conforming to the requirements of the contract and including all facilities and utilities as specified will be measured as a unit lump sum quantity.

When a Type 2 LO or Type 3 LO building is specified and the Contractor furnishes separate units as provided in Subsection 622.03.1.2, B, no additional measurement will be made because of the separate units but will be made as if the specified single unit had been furnished.

622.05--Basis of Payment. The Engineer's field office buildings or combination field laboratory and office building furnished as specified and measured as prescribed above will be paid for at the contract unit price bid per each, which price shall be full compensation for all materials, design, construction, furnishing, maintaining; for all fuel, water, sewage disposal, telephone service, electricity, including transformer if necessary, moving to and from the project and movements on the project, all as specified or directed by the Engineer as provided in the contract, and for all costs incidental thereto; except when the Engineer determines that the necessary location of the building is such that electrical current must be carried for the exclusive use of the Engineer for a distance in excess of 1,000 feet from its source, the cost of furnishing service lines in excess of 1,000 feet will be paid for as Extra Work.

Payment for each Engineer's field office building or LO building provided in accordance with the contract will be made in two installments. Sixty-five (65) percent of the contract price bid will be paid on the first monthly estimate after occupancy by the Engineer and the remaining thirty-five (35) percent will be paid when the use of the building has been concluded by the Engineer as provided herein.

Payment will be made under:

Section 622

622-A: Engineer's Field Office Building, Type ____

622-B: Engineer's Field Office Building, Type ____ LO

Section 622

- per each

- per each

SECTION 625 - PAINTED TRAFFIC MARKINGS

625.01--Description. This work consists of furnishing materials and applying reflectorized painted traffic markings in reasonably close conformity with these specifications and the details shown on the plans or established.

625.02--Materials. Paint shall be the color specified and shall meet the applicable requirements of Section 710.

Application of permanent painted traffic markings shall require Class B (High-Visibility) glass beads; otherwise, Class A (Standard) glass beads shall be required. Glass beads shall meet the requirements of Subsection 720.01.

625.03--Construction Requirements.

625.03.1--Equipment. All paint shall be applied by approved mechanical equipment providing constant agitation of paint, traveling at controlled speeds, with one or more paint "guns" synchronized to begin and cut off paint flow automatically for skip lines, and subject to manual control for continuous lines of varying length. The machine, or a separate machine, shall be equipped with a glass bead dispenser adjusted and so synchronized with the paint applicator as to distribute the beads uniformly on the painted lines within 10 seconds. Calibration charts and devices for measurement of tanks shall be provided by the Contractor for determining the quantity being applied.

All painting equipment and operations shall be under the control of an experienced technician thoroughly familiar with the equipment, materials, and marking layouts.

625.03.2--Preparation of Surface. All areas to be painted shall be thoroughly cleaned. Cleaning may be done by hand brooms, rotary brooms, air blast, scrapers, or whatever combination of equipment is necessary to clean the pavement thoroughly without damage to the surface. Before edge striping, particular care shall be taken to remove all vegetation, loose soil, and the like from the area to be painted. Should other methods fail, the surface shall be wetted with a water jet and scrubbed as necessary to dislodge all foreign material. After washing, the surface shall be allowed to dry thoroughly, and all films of dried mud apparent after surface drying shall be removed before application of paint. Painting shall follow as closely as practicable after the surface has been cleaned and dried, but no paint shall be applied until the surface has been inspected and permission given to proceed. The cost for preparing the surface shall be included in the unit prices for the marking items.

Upon request, the Engineer will establish control points for markings, by type and color, at necessary intervals not to exceed 600 feet. The Contractor shall

preserve and apply markings in conformity with control points established.

625.03.3--Application. The paint shall be applied when the ambient temperature is no less than 50°F, the pavement surface is properly prepared and the temperature of the pavement surface is no less than 50°F.

For four-inch temporary traffic stripe, paint and Class A glass beads shall be uniformly applied at the rate of not less than one gallon of paint and six pounds of beads per 264 linear feet of four-inch stripe. For six-inch permanent traffic stripe, paint and Class B glass beads shall be uniformly applied at the rate of not less than one gallon of paint and twelve pounds of beads per 176 linear feet of six-inch stripe.

The length and width of lines shall be within a tolerance of plus or minus three inches and plus or minus 1/8 inch, respectively. For skip markings, the tolerance for intervals shall not exceed the line length tolerance.

Markings applied at less than minimum material rates, deviating from true alignment by more than one inch in 50 feet, exceeding stipulated length and width tolerances, and showing light spots, faulty distribution of beads, smears, or other deficiencies or irregularities shall be removed and replaced. Removal methods shall be in accordance with Subsection 619.03.2.

625.03.4--Protection. The newly painted markings shall be protected so that, insofar as possible, paint will not be picked up by the tires of passing vehicles. Warning signs shall be placed at the beginning of a wet line and at points well in advance of the marking equipment. For the benefit of the Contractor, small flags or other similarly effective small objects may be placed near freshly applied lines at frequent intervals to reduce crossings by traffic. Damaged portions of stripes shall be effaced and replaced by the Contractor at no additional cost to the State.

Operations shall be conducted so that traffic can move without undue hindrance. When public traffic is being maintained, warning signs at the starting end shall be moved forward as sections of stripe dry sufficiently to prevent pick-up under traffic. Reference is made to Subsection 710.02.2.2 for the particular paint involved.

625.03.5--Detail Traffic Stripe. Detail traffic stripe shall be those short stripes, exclusive of lane and edge striping of the main facility, at exit and entrance ramps, turnouts, turn bays, and other locations indicated on the plans. When shown on the plans or directed by the Engineer, detail stripe of the color, width, and length shall be placed in accordance with the provisions and requirements of this section.

625.03.6--Legend. Legend shall be applied by the use of templates cut to the dimensions shown on the plans, or by other methods approved by the Engineer

which will provide a clean cut, uniform, and workmanlike appearance. All other requirements for legend shall be in accordance with the applicable materials and construction requirements of this section.

Legend which fails to have a uniform, satisfactory appearance either by day or by night shall be corrected by the Contractor or removed and replaced at no additional cost to the State.

625.04--Method of Measurement. Painted traffic markings completed in accordance with the plans and specifications will be measured by the mile or by the linear foot, as indicated, from end-to-end of individual stripes. In the case of skip lines the measurement will include skips. The length used to measure centerline, lane lines and edge stripes will be the horizontal length computed along the stationed control line.

Detail traffic stripe will be measured by the linear foot from end-to-end of individual stripes. Measurement will be made along the surface of each stripe and will exclude nominal skip intervals where specified. Stripes more than six inches in width will be converted to equivalent lengths of six-inch stripe.

Legend will be measured as provided for legend in 626.04.

625.05--Basis of Payment. Painted traffic markings will be paid for at the contract unit price per mile, linear foot, or square foot as applicable.

Restriping of in-place traffic stripe which was not initially placed under the contract will be measured and paid as Traffic Stripe Restriping when the contract includes a bid item for restriping. The restriping will be measured as prescribed above for traffic stripe and will be paid for at the contract unit price which shall be full compensation for preparation of the surface, furnishing and applying all materials, protection of wet paint; and for furnishing all labor, tools, equipment and incidentals necessary to complete the work.

The prices thus paid shall be full compensation for completing the work.

Payment will be made under:

625-A: Traffic Stripe, Skip White	- per linear foot or mile
625-B: Traffic Stripe, Skip Yellow	- per linear foot or mile
625-C: Traffic Stripe, Continuous White	- per linear foot or mile
625-D: Traffic Stripe, Continuous Yellow	- per linear foot or mile
625-E: Detail Traffic Stripe	- per linear foot

625-F: Legend	- per square foot or linear foot
625-G: Traffic Stripe Restriping, Skip	- per linear foot or mile
625-H: Traffic Stripe Restriping, Continuous	- per linear foot or mile
625-I: Traffic Stripe Restriping, Detail	- per linear foot

SECTION 626 - THERMOPLASTIC TRAFFIC MARKINGS

626.01--Description. This work consists of furnishing materials and placing thermoplastic pavement markings of the type specified in reasonably close conformity with these specifications and the details shown on the plans or established.

Cold plastic traffic markings may be used in lieu of hot applied thermoplastic markings. Substitution will only be allowed for pay items 626-A through H. Substituted cold plastic markings shall be of the same color and width as that required for the hot applied stripe. Unless otherwise specified, the markings, whether hot applied or cold plastic, shall be of the same type material for the entire project. Material and construction requirements for substituted cold plastic traffic markings shall meet the requirements of Section 628 of the Standard Specifications. The layout and spacing for substituted cold plastic traffic markings will remain as shown in the plans, or in the contract documents, for hot applied thermoplastic markings. Measurement of substituted cold plastic traffic markings shall be made in accordance with Section 628 of the Standard Specifications. Payment for substituted cold plastic traffic markings shall be made at the unit price bid for the appropriate hot applied thermoplastic marking.

626.02--Materials. The Department reserves the right to perform additional testing of thermoplastic traffic marking materials at any time. Upon request of the State Materials Engineer, samples of the thermoplastic compound, glass beads and epoxy resin shall be furnished.

626.02.1--Thermoplastic Material. Thermoplastic material shall meet the requirements of Subsection 720.02, except an alkyd resin shall be used in the formulation when used in construction of stop lines, crosswalks, and legends.

626.02.2--Glass Beads. Glass beads shall meet the requirements of Subsection 720.01. Unless otherwise noted, Class A glass beads shall be used.

626.03--Construction Requirements.

626.03.1--Thermoplastic Traffic Stripe.

626.03.1.1--Equipment. Equipment for hot application shall be of sufficient size and stability to insure smooth, uniform, properly aligned markings of the dimensions specified.

The application equipment shall be capable of automatic placement of intermittent and continuous line patterns in single or double line applications simultaneously. The intermittent timer mechanism shall provide a variable ratio of materials applied and variable cycle length such that accurate placement of new patterns, or replacement of existing patterns can be achieved.

The equipment shall also be capable of applying the top dressing of glass beads in a manner which will firmly embed them into the surface of the thermoplastic material for at least one half the diameter of the larger gradation sizes of the beads. The dispensing equipment shall be equipped with an automatic cut-off control for the application of the beads which is synchronized with the cut-off of the thermoplastic material.

626.03.1.2--Construction Details. Application of thermoplastic material shall be made only in periods of dry weather and when the temperature of the pavement surface is at least 55°F. The pavement shall be surface dry, to the satisfaction of the Engineer, before application will be permitted. The presence of moisture can be tested in accordance with the procedures set out in Subsection 626.03.2.4. The application temperature of the thermoplastic material shall be between 400° and 450°F.

Upon request, the Engineer will establish the control points for markings at necessary intervals not to exceed 600 feet on tangents and more often on curves. All additional work necessary to establish intermediate control points shall be performed by the Contractor. On curves, unsightly variations from the normal curvature will not be permitted unless specifically shown on the plans or ordered by the Engineer.

Immediately before application, the areas to receive markings shall be cleaned thoroughly in accordance with Subsection 625.03.2. On areas of pavement cured with compound, the membrane shall be removed completely by shot blasting, sand blasting or other approved method.

Unless otherwise directed by the Engineer, traffic stripes that are coincidental with the thermoplastic stripe shall be removed prior to placement of the thermoplastic material, except that temporary paint stripe may be left in place when satisfactorily placed in the proper location. Any temporary stripe not covered shall be removed. Payment for removal of stripe, except temporary stripe, will be made under Section 202.

When thermoplastic material is to be applied to portland cement concrete pavements or bridge surfaces, a binder-sealer of the type and amount

recommended by the manufacturer of the thermoplastic material shall be applied prior to placement of the thermoplastic material. On other pavement surfaces, a binder-sealer shall be applied under those conditions recommended by the manufacturer of the thermoplastic material.

The thickness of the thermoplastic material, when measured above the surface plane of the pavement, shall be within tolerance of the specified thickness. Unless otherwise specified in the plans or contract documents, the thickness shall be 60 mils for edge lines, 90 mils for center lines, lane lines, barrier lines and detail stripe including gore markings, and 120 mils for crosswalks, stop lines, and railroad, word and symbol markings. The measured thickness at the center of the line shall be no less than the specified thickness with the edge of the line not thinner than 75% of the specified center thickness and will be checked at intervals of one mile or less as directed by the Engineer.

Any thermoplastic traffic marking less than the required thickness shall be corrected by overlaying with an additional application of thermoplastic material. Any such required overlay will be no less than 30 mils. Although a tolerance of 25 percent from center to edge is allowed, a consistent underrun of any amount in thickness will not be acceptable.

Additional beads by the drop-on method shall be applied at a rate of not less than three pounds of beads per 100 feet of six-inch stripe.

All newly applied thermoplastic material shall be protected from traffic until the material is sufficiently dry so as not to sustain damage from vehicle tires. Any material so damaged, marred or picked up by traffic shall be repaired, and the thermoplastic material tracked onto the pavement shall be removed.

The length and width of lines shall be within a tolerance of plus or minus three inches and plus or minus 1/8 inch, respectively. For skip markings, the tolerance for intervals shall not exceed the line length tolerance.

626.04--Method of Measurement. Thermoplastic stripe completed in accordance with the plans and specifications will be measured by the mile or by the linear foot, as indicated, from end-to-end of individual stripes. In the case of skip lines the measurement will include skips. The length used to measure centerline, lane lines and edge stripes will be the horizontal length computed along the stationed control line.

Detail traffic stripe will be measured by the linear foot from end-to-end of individual stripes. Measurements will be made along the surface of each stripe and will exclude skip intervals where skips are specified. Stripes more than six inches in width will be converted to equivalent lengths of six-inch stripe.

Legend, which is to include railroad markings, pedestrian crosswalks and stop

lines, will be measured by the square foot or linear foot. Pay areas of individual letters and symbols will usually be shown on the plans and measured by the square foot. Transverse railroad bands, pedestrian crosswalks and stop lines will generally be measured by the linear foot, in which case, stripes more than six inches in width will be converted to equivalent lengths of six-inch widths.

626.05--Basis of Payment. Thermoplastic traffic markings will be paid for at the contract unit price per mile, linear foot, or square foot, as applicable, which shall be full compensation for completing the work.

Payment will be made under:

626-A: 6" Thermoplastic Traffic Stripe, Skip White	- per linear foot or mile
626-B: 6" Thermoplastic Traffic Stripe, Continuous White	- per linear foot or mile
626-C: 6" Thermoplastic Edge Stripe, Continuous White	- per linear foot or mile
626-D: 6" Thermoplastic Traffic Stripe, Skip Yellow	- per linear foot or mile
626-E: 6" Thermoplastic Traffic Stripe, Continuous Yellow	- per linear foot or mile
626-F: 6" Thermoplastic Edge Stripe, Continuous Yellow	- per linear foot or mile
626-G: Thermoplastic Detail Stripe, <u>Color</u>	- per linear foot
626-H: Thermoplastic Legend, White	- per linear foot or square foot

SECTION 627 - RAISED PAVEMENT MARKERS

627.01--Description. This work consists of furnishing and placing pavement markers of the types, colors, shapes, and dimensions specified and in reasonably close conformity with the location, lines, and details shown on the plans or as directed by the Engineer.

627.02--Materials. Pavement and jiggle markers of the types specified shall conform to the applicable requirements of Subsection 720.03 and shall be listed on the Department's "Approved Sources of Materials".

Type B through G High Performance reflective markers shall be listed on the Department's "Approved Sources of Materials" for high performance raised pavement markers.

The bituminous adhesive for pavement markers shall meet the requirements of Subsection 720.03.7.

627.03--Construction Requirements.

627.03.1--General. Unless waived by the State Construction Engineer on the basis of known performance qualifications, the Contractor or approved subcontractor shall certify to the Engineer that sufficient experience has been acquired in the placement of the required markers, or the Contractor or approved subcontractor shall require the manufacturer of the markers to have a qualified technical representative on or immediately available to the project during the application of the markers to assist the Contractor's personnel in the proper application of the adhesive and markers and to render technical assistance to the Engineer as may be deemed desirable.

Any such waiver shall be subject to the conditions set forth in the waiver.

627.03.2--Construction Details. The markers shall be installed when the relative humidity of the air is 80% or less, the pavement surface is dry and the temperature of the pavement surface is no less than 50°F. Other pavement marking materials, such as thermoplastic, cold plastic and paint, shall be placed prior to installation of markers.

The portion of the highway surface to which the marker is to be bonded shall be cleaned so as to be free of dirt, curing compound, grease, oil, moisture, loose or unsound layers, paint and any other material which would adversely affect the bond of the adhesive.

The bituminous adhesive shall be melted and heated in either thermostatically controlled double boiler type units utilizing heat transfer oil or thermostatically controlled electric heating pots. Direct flame melting units shall not be used. The melter/applicator unit shall be suited for both melting and pumping application through heated applicator hoses.

The adhesive shall be heated to between 375°F and 425°F and applied directly to the pavement surface from the melter/applicator by either pumping or pouring. It is important that application temperature be maintained between 375°F and 425°F as lower temperatures may result in decreased adhesion while higher temperatures may damage the adhesive.

The adhesive should be applied in a puddle approximately two-thirds to three-fourths the diameter of the marker. Markers should be applied to the adhesive

within 10 seconds to assure bonding. The marker shall be placed in position by applying downward pressure until the marker is firmly seated with the required adhesive thickness and squeeze out. Excessive adhesive squeeze out shall be removed from the pavement and adhesive on the exposed surfaces of the markers shall be immediately removed. Soft rags moistened with mineral spirits conforming to Federal Specification TT-T-291 or kerosene may be used if necessary, to remove adhesive from exposed faces of pavement markers. No other solvent shall be used.

All markers shall be installed in a uniform line, with controls established by the Engineer. The Engineer will establish controls for each line of markers by setting control points at not less than approximately 600-foot intervals on tangents and 50-foot intervals on curves. All additional work necessary to establish intermediate control points and individual marker points shall be performed by the Contractor, including smoothing out minor irregularities in any line established by the Engineer. On curves, the line of markers on lane lines and edge lines shall follow the normal curvature of the curve and placement on chords or other variations from the normal curvature will not be permitted, unless specifically shown on the plans or ordered by the Engineer.

Reflective markers shall be installed in such a manner that the reflective face of the marker is perpendicular to a line parallel to the roadway centerline. No markers shall be installed over longitudinal or transverse joints of the pavement surface.

The marker shall be protected against impact until the adhesive has hardened. The Engineer shall be the judge as to the minimum time necessary to cure the adhesive for sufficient set to bear traffic.

The adhesive may be reheated and reused. However, the pot life at application temperatures shall not be exceeded.

Clean out of equipment and tanks may be performed using petroleum solvents such as diesel fuel or similar materials. CAUTION: Be sure that all heating is off before cleaning operations are begun. All solvent must be removed from the equipment tanks and lines before the next use of the melter.

627.04--Method of Measurement. Raised pavement markers of the type specified will be measured per each as determined from actual count in place.

627.05--Basis of Payment. Raised pavement markers of the type specified will be paid for at the respective contract unit price per each, which shall be full compensation for completing the work.

Payment will be made under:

Section 627	Section 627
627-A: Type A, Non-Reflective White Raised Jiggle Markers	- per each
627-AY: Type AY, Non-Reflective Yellow Raised Jiggle Markers	- per each
627-B: Two-Way Clear Reflective Raised Markers	- per each
627-C: Red-Clear Reflective Raised Markers	- per each
627-D: Two-Way Yellow Reflective Raised Markers	- per each
627-E: One-Way Clear Reflective Raised Markers	- per each
627-F: One-Way Yellow Reflective Raised Markers	- per each
627-G: Yellow-Clear Reflective Raised Markers	- per each
627-H: Chip Seal Reflective Raised Markers	- per each
627-J: Two-Way Clear Reflective High Performance Raised Markers	- per each
627-K: Red-Clear Reflective High Performance Raised Markers	- per each
627-L: Two-Way Yellow Reflective High Performance Raised Markers	- per each
627-M: One-Way Clear Reflective High Performance Raised Markers	- per each
627-N: One-Way Yellow Reflective High Performance Raised Markers	- per each
627-O: Yellow-Clear Reflective High Performance Raised Markers	- per each

SECTION 628 - COLD PLASTIC PAVEMENT MARKINGS

628.01--Description. This work consists of furnishing materials and installing cold plastic pavement markings of the type specified in reasonably close conformity with the plans and these specifications.

Cold plastic traffic markings may be used in lieu of hot applied thermoplastic markings. Substitution will only be allowed for pay items 626-A through H. Substituted cold plastic markings shall be of the same color and width as that required for the hot applied stripe. Unless otherwise specified, the markings, whether hot applied or cold plastic, shall be of the same type material for the

entire project. Material and construction requirements for substituted cold plastic traffic markings shall meet the requirements of this section of the Standard Specifications. The layout and spacing for substituted cold plastic traffic markings will remain as shown in the plans, or in the contract documents, for hot applied thermoplastic markings. Measurement of substituted cold plastic traffic markings shall be made in accordance with this subsection of the Standard Specifications. Payment for substituted cold plastic traffic markings shall be made at the unit price bid for the appropriate hot applied thermoplastic marking.

628.02--Materials. Cold plastic marking material shall meet the requirements of Subsection 720.04. High performance cold plastic marking material shall meet the requirements of Subsection 720.07.

628.03--Construction Requirements.

628.03.1--Equipment. The material manufacturer shall furnish a mechanical applicator for the application of 16-inch wide film. When high performance profile cold plastic pavement markings are used, the manufacturer shall provide application equipment, manual or automatic as necessary for the job requirements. These applicators shall be capable of applying markings to the required alignment and dimensions shown on the plans or in the contract documents. The mechanical applicator shall be provided on location at the time designated and for the duration of the application period. The material manufacturer shall provide technical assistance for operation and maintenance of the mechanical applicator at the discretion of the Engineer.

628.03.2--General. The free-air temperature shall be at least 60°F. The pavement surface shall be dry and clean. All dirt, loose particles of pavement, and other foreign material shall be removed prior to application of the pavement marking material. All longitudinal stripes shall be mechanically applied. Detail stripe and legend may be applied manually. Only butt splices without overlay will be permitted for multiple piece and line type markings. Except for legend, the specified width of the markings shall be made in a single tape application. Where possible the markings shall be placed adjacent to rather than on longitudinal construction joints in the pavement. Placement tolerance will be those set out in Subsection 625.03.3. Markings not meeting these tolerances shall be removed and replaced at the Contractor's expense.

628.03.3--Application. Both mechanical and manual application shall be in accordance with the manufacturer's instructions. A liquid contact shall be used at the rate recommended by the manufacturer for detail stripe and legend symbols. Liquid contact cement shall not be used elsewhere unless specified by the manufacturer. When liquid contact cement is used, the newly placed markings shall be protected from traffic for the period of time recommended by the manufacturer of the cement.

628.04--Method of Measurement. Cold plastic pavement markings will be measured for payment in accordance with Subsection 626.04.

628.05--Basis of Payment. Cold plastic pavement markings will be paid for at the contract unit price per mile, linear foot or square foot, as applicable, which shall be full compensation for completing the work.

Payment will be made under:

628-A: 6" Cold Plastic Traffic Stripe, Skip White	- per linear foot or mile
628-B: 6" Cold Plastic Traffic Stripe, Continuous White	- per linear foot or mile
628-C: Blank	
628-D: 6" Cold Plastic Traffic Stripe, Skip Yellow	- per linear foot or mile
628-E: 6" Cold Plastic Traffic Stripe, Continuous Yellow	- per linear foot or mile
628-F: Blank	
628-G: Cold Plastic Detail Stripe, <u>Color</u>	- per linear foot
628-H: Cold Plastic Legend, White	- per square foot or linear foot
628-I: 6" High Performance Cold Plastic Traffic Stripe, Skip White	- per linear foot or mile
628-J: 6" High Performance Cold Plastic Traffic Stripe, Continuous White	- per linear foot or mile
628-K: Blank	
628-L: 6" High Performance Cold Plastic Traffic Stripe, Skip Yellow	- per linear foot or mile
628-M: 6" High Performance Cold Plastic Traffic Stripe, Continuous Yellow	- per linear foot or mile
628-N: Blank	

628-O: High Performance Cold Plastic Detail Stripe, <u>Color</u>	- per linear foot
628-P: High Performance Cold Plastic Legend, White	- per square foot or linear foot

SECTION 629 - VEHICULAR IMPACT ATTENUATORS

629.01--Description. This work consists of furnishing all materials, components and accessories and installing impact attenuator systems meeting all of the requirements specified on the plans or in other contract documents, and assembled and constructed at the location(s) indicated on the plans or as established by the Engineer.

This work shall also include the installation of median barrier end sections in accordance with the plans, specifications, and the manufacturer's recommendations.

629.02--Materials. Materials used in the construction of the vehicular impact attenuator system shall all be new and shall conform to the applicable requirements of the respective section(s) of Section 700, as may be supplemented by requirements in other contract documents for the particular system installation.

The impact attenuators used must be one as shown on the Department's "Approved Sources of Materials". Replacement packages shall consist of spare parts of the expected type and number needed to repair one hit for each attenuator unit installed.

629.03--Construction Requirements.

629.03.1--Fabrication and Construction. The plans and other contract documents will detail and the system assembly shall be constructed in accordance with the requirements for the fabrication and construction of the attenuator system. For manufactured products specified, unless otherwise indicated in the contract, the system shall be fabricated and installed in accordance with the manufacturer's recommendation; in such case, the Contractor shall obtain the manufacturer's recommended installation instructions, including erection diagrams, and shall furnish the Engineer with a complete copy of such recommended installations and instructions.

In the fabrication and construction of any vehicular impact attenuator system, sharp edges, projections, and any misfits of fabrication or construction shall be avoided.

Installation of impact attenuators shall be accomplished by experienced workmen

in accordance with the recommendations of the manufacturer. As a replacement supply, the Contractor shall furnish a spare parts package. The quantity and materials of this package will be that necessary to repair one hit for each attenuator unit installed. The Contractor shall use these parts to maintain the attenuator until release of maintenance. Upon completion of the work the replacement packages shall become the property of the Contractor.

The median barrier end section and vehicular attenuator back-up wall shall be constructed in accordance with the plans, the manufacturer's recommendations, applicable provisions of Section 615 and other applicable provisions of the Standard Specifications.

629.04--Method of Measurement. Vehicular impact attenuators will be measured as a unit for each complete attenuator installed and accepted. One replacement package shall be included in the bid price for each attenuator.

Median barrier end sections and vehicular attenuator back-up wall will be measured as a unit for each complete and accepted section.

Foundations for attenuators and median barrier end sections are considered parts of the respective units and will not be measured for separate payment.

629.05--Basis of Payment. Vehicular impact attenuators, median barrier end sections and vehicular attenuator back-up wall will be paid for at the contract unit price per each. In the event an additional replacement package is required during the life of the contract, 25% of the lump sum price will be allowed to place the unit back in operation. Payment for the above listed units shall be full compensation for the work and materials required under this Section.

Payment will be made under:

- 629-A: Vehicular Impact Attenuator, Speed Rating - per each
- 629-B: Median Barrier End Section - per each
- 629-C: Vehicular Impact Attenuator Back-up Wall - per each

SECTION 630 - TRAFFIC SIGNS AND DELINEATORS

630.01--Description. This work consists of furnishing and installing delineators, traffic signs, sign supports, framing, and panels in reasonably close conformity with the requirements shown on the plans and set out in these specifications.

The work and materials shall conform to the requirements of the MUTCD, current on the date of receipt of bids, except as modified by these specifications

or as shown on the plans.

The bidder or the bidder's proposed supplier may be required to show satisfactory evidence of successful experience in fabrication of reflectorized multi-panel highway signs prior to award of the contract. Bidders may also be required to show evidence of successful experience or capability in erection of reflectorized multi-panel highway signs.

When specified as Contractor Designed Metal Overhead Sign Supports, the Contractor will be responsible for the design of the metal overhead sign support(s) and overhead sign supports on bridges(s). The design shall meet the latest requirements of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals.

The Contractor shall submit to the Bridge Engineer a design using steel. The design shall be a rectangular box truss. Design drawings, calculations and other necessary supporting data shall be submitted as soon as possible after the Pre-Construction Conference. The design shall be prepared by a Professional Engineer registered in the State of Mississippi proficient in the design of overhead sign structures.

The design wind speed shall be a minimum of 70 mph. Overhead sign supports shall be designed to support, in addition to loads required in the design specifications, a uniform load of 40 pounds per linear foot applied to the vertical truss to which the signs are attached, extending along the truss across the roadway below from points four feet outside each outer edge of pavement, unless otherwise specified.

630.02--Materials. Materials for signs and delineators shall meet the requirements of Section 721.

Although certain particular brands, makes of materials, devices, processes, and/or equipment are named herein for the purpose of establishing minimum acceptable standards, it is neither implied nor intended that those named are to be considered to the exclusion of comparable brands, materials, devices, processes, or equipment.

All warranties, guaranties, and instruction sheets normally furnished by the manufacturer for materials and supplies used in the work shall be delivered to the Engineer prior to final acceptance of the project.

Material for Contractor designed metal overhead sign supports shall meet the following:

Reinforcing Steel. Reinforcing steel used in reinforced concrete footings shall be in accordance with Subsection 602 and meet the requirements of ASTM

Designation: A 615, Grade 60.

Anchor Bolts. Material for anchor bolts shall meet the requirements of ASTM Designation: A 36; anchor bolts shall be hot-dipped galvanized in accordance with ASTM Designation: A 153, Class C; threads and nuts for anchor bolts shall be lubricated with a visible dye so that a visual check can be made for proper lubrication prior to installation.

Structural Steel. Material for posts, chords and bracing members shall meet the requirements of ASTM Designation: A 501 or ASTM Designation: A 53, Grade B.

Material for structural shapes, plates, posts and chord caps shall meet the requirements of ASTM Designation: A 36.

Material for round tapered monotube shall meet the requirements of ASTM Designation: A 595, Grade A.

630.02.1--Fabrication of Signs and Sign Panels. Signs shall be fabricated in a properly equipped shop owned and operated by the Contractor or approved subcontractor or supplier.

630.02.2--Fabrication of Aluminum Extrusions and Sheets. The fabrication of aluminum extrusions and sheets shall generally conform to or be equivalent to the fabrication methods and practices recommended in the handbook of the major producers of aluminum materials and the following specific requirements:

- (a) Materials shall be sawed or milled. Sheets 1/2 inch or less in thickness may be sawed, blanked, sheared, or milled.
- (b) Flame cutting will not be permitted.
- (c) Re-entrant cuts shall be avoided wherever possible. If used, they shall be filleted by drilling prior to cutting.
- (d) Holes in extrusions shall be drilled.
- (e) Holes in sheet aluminum may be drilled to finish size or they may be blanked to finished size provided the diameter of the blanked hole is at least twice the thickness of the metal being blanked.
- (f) Aluminum shall be free of buckles, warp, dents, cockles, burrs, ragged breaks, and defects resulting from fabrication. Cut edges shall be true and smooth. The surface shall be flat.
- (g) Before placing aluminum in contact with steel, the steel surface shall be

coated by galvanizing. Aluminum alloys shall not be placed in contact with copper, copper base alloys, lead, or nickel.

- (h) In handling, precautions shall be taken to prevent scratches, gouges, and abrasion.

630.02.3--Preparation of Aluminum for the Application of Reflective Sheeting. Extruded aluminum and flat sheet aluminum sign panels to which reflective sheeting is to be applied shall be prepared as follows:

Preliminary Cleaning. The panel shall be completely submerged in a six percent (6%) solution of an inhibited alkaline cleaner at 160°F to 180°F for three minutes, followed by a thorough rinse with clean, running cold water. A grease solvent such as mineral spirits or naphtha, conforming to ASTM Designation: D 235, or trichloroethylene, conforming to ASTM Designation: D 4080, may be used.

Surface Preparation. For flat sheet aluminum, preliminary cleaning shall be followed by a surface treatment with a six to eight percent (6% to 8%) solution of phosphoric acid applied to the surface by immersion or brushing. The solution shall be allowed to remain on the surface for five minutes and then thoroughly rinsed with running cold water followed by hot water tank rinse.

Drying. The panels shall be dried by the use of forced warm air.

Handling. Metal shall not be handled except by device or clean canvas gloves between all cleaning and etching operations and the application of reflective sheeting. There shall be no opportunity for metal to come in contact with grease, oils, or other contaminants prior to painting.

630.02.4--Preparation of Aluminum for Painting. Aluminum which is to be painted shall be cleaned and prepared by a process conforming to ASTM Designation: D 1730, Type B Chemical Treatment. Metal shall not be handled except by device or clean canvas gloves between all cleaning and etching operations and the application of paint. There shall be no opportunity for metal to come in contact with greases, oils, or other contaminants prior to painting.

630.02.5--Blank.

630.02.6--Blank.

630.02.7--Reflective Sheeting. Reflective sheeting shall be applied to properly treated base panels with mechanical equipment in a manner specified for by the sheeting manufacturer. Type II adhesive coated sheeting shall be pre-perforated.

Sign faces comprising two or more pieces of panels of reflective sheeting shall be

carefully matched for color at the time of sign fabrication to provide uniform appearance and brilliance during both day and night. Alternate, successive width sections of either sheeting or panels must be reversed and consecutive to insure that corresponding edges of reflective sheeting lie adjacent on finished sign. Non-conformance may result in non-uniform shading and an undesirable contrast between adjacent width of applied sheeting which will not be acceptable.

At splices, Type I adhesive coated sheeting shall be over-lapped at least 3/16 inch. Type II adhesive coated sheeting may be spliced with an overlap of at least 3/16 inch or butted with a gap not to exceed 1/32 inch. Only butt splices will be permitted with transparent screen processing. Sheeting applied to extruded sections shall extend over top edges and down side legs a minimum of 1/16 inch.

Reflective sheeting splices and sign edges shall be sealed with materials supplied and in the manner specified by the sheeting manufacture.

630.02.8--Removable Copy. Removable letters, numerals, symbols, and border are to be placed on the sign in accordance with the plans or as directed by the Engineer. This removable copy shall be attached to the sign from the front by means of a huck or cherry rivet gun and aluminum pull-through rivets without the use of clips.

Route markers used on structural panels with removable copy shall be made up as standard route markers on flat sheet metal as specified and shall be riveted to the structural panel. These route markers will not be paid for as separate signs but shall be considered as part of the major sign to which they are affixed.

630.02.9--Silk Screening. Where specified on the plans, sign letters, numerals, symbols, and border shall be applied to the sign panel by direct or reverse silk screen method. The letters shall be in accordance with the plans and series letters as set out by "Standard Alphabets for Highway Signs" which can be obtained from the Federal Highway Administration.

Unless otherwise specified, all silk screen legend shall be on silver-white or yellow reflective sheeting background.

Screening shall be accomplished in the manner specified by the sheeting manufacturer. Processing may be accomplished either before or after application of the sheeting to the flat, smooth base panels.

630.02.10--Packing, Storing and Shipping Signs. Signs shall be slip sheeted and packed in such a manner as to insure their arrival at their destination in undamaged condition. Signs shall be stored on edge in a cool, dry place, and shall not be allowed to become wet during shipment or storage.

630.02.11--Shop Drawings. The Contractor shall submit for the approval of the

Engineer scale drawings of all sign faces, showing arrangements and spacing of all letters, numerals, symbols, and border. For each type of sign support to be used with each different type of sign panel, the Contractor shall submit detailed drawings of the proposed method of attaching the sign to the supports on all signs not detailed on the plans. Shop drawings of all individual removable letters, numerals and symbols as well as layout templates for silk screens shall be submitted to the Engineer for approval before templates or screens are made.

630.02.12--Welding. Any welding shall conform to the requirements of Subsection 630.03.8. Welding for Contractor designed metal overhead sign supports shall conform to the latest edition of AWS D1.1 for structural steel.

630.03--Construction Requirements.

630.03.1--Construction Stakes. Unless the contract has provisions for construction staking by the Contractor, the Engineer will furnish and set construction stakes for signs and will furnish the Contractor with all required information relating to lines and grades.

The Contractor shall check all leading dimensions and clearances measured from such stakes and thereafter will be responsible for orientation, elevation, offset, and level of all signs so erected.

630.03.2--Sign Positioning. The glossy surface on sign faces may produce specular reflection. Signs shall be positioned to eliminate or minimize specular reflection.

630.03.2.1--Overhead Signs. Unless otherwise directed by the Engineer, signs shall be erected at right angles to the road and so that the sign face is tilted back or is vertical as determined by the approach grade of the roadway or shown on the plans.

630.03.2.2--Ground-Mounted Signs. Signs shall be erected so that the sign face is truly vertical and at 93 degrees away from the center of the lane which the sign serves and the direction of travel unless otherwise directed by the Engineer. Where lanes divide and on curves, sign faces shall be oriented so as to be most effective both day and night and to avoid the possibility of specular reflection.

630.03.2.3--Vertical and Horizontal Clearances. All signs shall be installed so as to meet the vertical and horizontal clearances shown on the plans or if not shown the minimum clearance given in the MUTCD shall apply.

630.03.3--Excavation. The Contractor shall perform the excavation required for sign installation to neat lines by suitable means.

630.03.4--Posts. All posts shall be set at the required line and grade. Unless

otherwise shown on the plans, all posts except delineator posts shall be set in Class "B" concrete. Any required reinforcing steel will be shown on plans. Exposed concrete shall be finished with a steel float to the slope shown on the plans.

Footings for overhead sign supports shall be Class "B" concrete and shall be in accordance with the required dimensions, alignment, grades, reinforcement, and method of placement shown on the plans.

Treated timber posts shall be set in holes of the specified depth and of sufficient diameter to allow proper tamping and compaction or backfill. The backfill shall be made with the most suitable earth available and shall be tamped until the post is firm and rigid in a vertical position.

Pipes used for posts shall be capped by suitable means to exclude moisture.

630.03.5--Framing. Framing for ground-mounted signs shall be as shown on the plans. Holes may be field punched as permitted by the Engineer. All steel used for framing shall be galvanized.

630.03.6--Erection of Signs. Signs shall be erected in a neat and workmanlike manner.

After installation is complete, signs will be inspected at night by the Engineer. If specular reflection is apparent on a sign, its positioning shall be adjusted by the Contractor to eliminate this condition.

630.03.7--Erection of Delineators. The location of each type of delineators shall be as shown on the plans. The post shall be driven and a driving cap used to protect the curb. Posts shall be driven vertically and driving caps used to protect the posts. Delineator shall be attached to the posts as shown on the plans by means of a huck or cherry tool and aluminum fastener.

630.03.8--Overhead Sign Supports.

630.03.8.1--Fabrication. Metal overhead sign support structures shall be either all aluminum or all steel. They shall be fabricated as shown on the plans in a properly equipped plant. All welds shall be performed in the shop by certified welders. Welding for steel structures shall conform to the requirements of Subsections 810.03.5 and 810.03.6.

Welding for aluminum structures shall meet the requirements for the fabrication of welded aluminum structures as set out in the AASHTO Standard Specifications for Structural Supports for Highway Signs, except that the filler metals to be used with particular base metals shall be as specified in Subsection 721.03.3.

Unless a particular edition of the AASHTO specifications is indicated on the plans, the edition current at the time of receipt of bids shall be applicable.

Prior to installation, the surface of aluminum shoe bases to be placed in contact with concrete shall be given a heavy coat of an alkali-resistant black coal tar epoxy paint meeting the requirements of Steel Structures Painting Council Paint Specification No. SSPC-Paint 16. The paint shall be applied in accordance with the manufacturer's recommendation and as it is received from the manufacturer without the addition of thinner.

The Contractor may provide a neoprene pad of the dimensions and shape shown on the plans to be placed between the aluminum shoe bases and the concrete as a substitute for the shoe-base paint requirements.

Each Contractor designed metal overhead sign support structure shall be match-marked and assembled in the shop for inspection prior to shipment.

630.03.8.2--Shop Drawings. Shop drawings of the structures shall be submitted for approval in accordance with Subsection 810.02.2. They shall show the required vertical camber for the horizontal support and method of fabricating, including welding procedure.

Shop drawings and design calculations for Contractor designed metal overhead sign supports shall be submitted to the Bridge Engineer in triplicate for review prior to fabrication. Shop drawings shall show all members, connections (welds), footings and details necessary for a complete structure. The required truss camber and method of fabricating shall also be shown.

630.03.8.3--Inspection and Testing. Unless waived in writing by the Engineer, inspection of the fabrication will be required. Each structure shall be match marked and assembled in the shop prior to inspection. Steel structures to be galvanized shall be match marked and assembled for inspection prior to galvanizing. Additional inspections for galvanized steel structures may be required before and/or after galvanizing. The Engineer shall be notified at least 24 hours prior to the time that an inspection is scheduled. The structures shall be checked for alignment, sound welds, and general workmanship. Four copies of a certification by the galvanizer that galvanizing meets the appropriate specification shall be furnished to the State Materials Engineer. Mill test reports on material in primary members shall be submitted in accordance with Subsection 810.03.25.

Shop inspection is required for Contractor designed metal overhead sign supports to ensure that fabrication and welding comply with the contract requirements. A commercial testing laboratory retained by the Department will perform the inspection but this inspection does not relieve the fabricator of any responsibility regarding complying with the contract requirements. A pre-fabrication

conference shall be required unless waived by the Bridge Engineer. No fabrication of any structure shall begin until approved drawings and welding procedures have been distributed, the pre-fabrication conference held, and authorization for the work to begin given by the Bridge Engineer.

630.03.9--Removal of In-Place Signs, Markers and Posts. The Contractor shall salvage existing signs, markers, and posts and stockpile them at the locations shown on the plans. Signs and markers shall be removed from posts and be stacked on edge with paper separators between units. Posts shall be pulled without being bent and stockpiled off the ground. All handling, hauling, and storing shall be such as to avoid damage. This work shall be incidental to items of the contract, and separate payment will not be allowed.

630.03.10--Bolt Connections for Contractor Designed Metal Overhead Sign Supports. High-strength bolts shall meet the requirements of ASTM Designation: A 325, Type I and shall be no larger than one inch (1") in diameter; bolts other than high-strength shall meet the requirements of ASTM Designation: A 307, Grade A. Nuts for all bolts shall meet the requirements of ASTM Designation: A 563; nuts for high-strength bolts shall be heavy hex, Grade DH; nuts for all other bolts shall be hex, Grade A; all nuts shall be lubricated with a visible dye so that a visual check can be made for proper lubrication prior to installation. All washers shall meet the requirements of ASTM Designation: F 436. All fasteners (bolts, nuts and washers) shall be galvanized in accordance with ASTM Designation: A 153, Class C. All connections using high strength bolts require Direct Tension Indicators (DTIs). DTIs shall meet the requirements of ASTM Designation: F 959-90 and shall be mechanically galvanized in accordance with ASTM Designation: B 695, Class 50 coating.

630.03.11--Galvanizing for Contractor Designed Metal Overhead Sign Supports. Steel assemblies shall be galvanized after fabrication in accordance with the latest requirements of ASTM Designation: A 123. Damage to the galvanized coating shall be repaired subsequent to erection by a method approved by the Bridge Engineer. Holes may be drilled in structural steel members as needed for venting during galvanizing. Such holes shall be in accordance with the following requirements: No holes shall be greater than eleven sixteenths inch (11/16") in diameter; holes for bracing members of columns and trusses may be drilled in either the wall of the bracing member or the wall of the column post or truss chord at each end, except for trusses, no holes shall be drilled in the wall of vertical diagonals and no holes shall be drilled in wall of chords at either end of horizontal struts, horizontal diagonals or interior diagonals. Holes drilled in the wall of vertical struts for trusses shall face toward the center of the truss; holes drilled in the wall of all other bracing members shall be located so that they face downward when the structures are erected. When necessary, one hole for a member may face upward if there is an opposite hole facing downward. No bracing member shall have more than one hole at each end. Holes shall be drilled and shall be located at a distance not to exceed the

outside diameter of the member from the end of the member.

630.03.12--Final Cleaning Up. The Contractor shall remove all rejected and unused materials and debris from the right-of-way. Shoulders and slopes shall be restored to their original condition. Excess excavation shall be disposed of off the right-of-way at the Contractor's expense unless otherwise directed by the Engineer. Before final inspection, the Contractor shall perform such touching up of paint finishes, cleaning of exposed sign and support surfaces, and other cleaning up as may be necessary to insure the effectiveness and neat appearance of the work.

630.04--Method of Measurement. Standard sheet aluminum signs will be measured by the square foot of sign face for each specified thickness.

Extruded aluminum signs, including removable copy, will be measured by the square foot of sign face.

Built-up steel panel signs, including removable copy, will be measured by the square foot of sign face. Structural steel used in building up the sign panel system will not be measured for separate payment.

In determining the area of sign faces, no deduction will be made for corner radii or mounting holes. The area of octagonal signs, U.S. shields, and Interstate shields will be computed as the area of the circumscribing square or rectangle. The area of the triangular signs will be computed as the area of the triangle.

Steel U-section posts will be measured by the linear foot of each specified size.

Timber posts will be measured by the unit.

Structural steel beams for vertical sign supports will be measured by the linear foot of each specified size.

Structural steel angles and bars, or channels, used for lateral bracing of vertical sign supports will be measured by the pound.

Steel pipe posts will be measured by the linear foot of each specified size.

Concrete for overhead sign support foundations will not be measured for separate payment. Such costs shall be included in the cost of the overhead sign assembly. Concrete for roadside signs will be measured in cubic yards in accordance with Section 601. In computing the volume, the neat dimensions shown on the plans will be used except for variations as may be ordered by the Engineer.

Reinforcement, when called for on the plans, will be measured in pounds in accordance with Section 602.

Excavation will not be measured for separate payment and the cost thereof shall be considered incidental to and included in the unit prices bid for footings, posts, etc.

Paint and painting will not be measured for separate payment and the cost thereof shall be included in unit prices bid for items painted.

Metal overhead sign support assemblies will be measured by the unit.

Delineators and object markers will be measured by the unit, including post, fastener, and single or multiple units as specified.

630.05--Basis of Payment. Signing items, measured as prescribed above, will be paid for at the respective contract unit or lump sum price, which price shall be full compensation for completing the work.

Payment will be made under:

630-A: Standard Roadside Signs, <u>Description</u>	- per square foot
630-B: Interstate Directional Signs, <u>Description</u>	- per square foot
630-C: Steel U-Section Posts, <u>Weight</u>	- per linear foot
630-D: Structural Steel Beams, <u>Description</u>	- per linear foot
630-E: Structural Steel Angles and Bars, <u>Description</u>	- per pound
630-F: Delineators, <u>Mounting</u> , <u>Description</u>	- per each
630-G: Type ____ Object Markers, <u>Description</u> , <u>Mounting</u> , <u>Color</u>	- per each
630-H: Treated Timber Posts, <u>Size and Length</u>	- per each
630-I: Metal Overhead Sign Supports, Assembly No. ____, <u>*</u>	- lump sum
630-J: Overhead Sign Supported on Bridge, Assembly No. ____, <u>*</u>	- lump sum
630-K: Welded & Seamless Steel Pipe Posts, <u>Size</u>	- per linear foot

* Indicate when the sign is "Contractor Designed"

SECTION 631 - FLOWABLE FILL

631.01--Description. This work shall consist of furnishing and placing a flowable fill material. Uses include, but are not limited to, placement under existing bridges, around or within box culverts or pipe culverts, or at other locations shown on the plans.

631.02--Materials. All materials shall meet the requirements of the following Subsections, or as stated herein:

Fine Aggregate.....	*
Portland Cement	701.01 and 701.02
Fly Ash	714.05
Air Entraining Admixtures **	713.02
Water	714.01.0 and 714.01.2

* Fine Aggregate gradation shall be fine enough to stay in suspension in the mortar to the extent required for proper flow and shall conform to the following grading:

<u>Sieve Size</u>	<u>% Passing</u>
1/2 inch	100
No. 200	< 1

** High air generators shall be used. These generators increase the fill’s air content to 15 - 35% while reducing settlement and bleed water. Only approved air generators will be allowed to be used to obtain the required air content.

631.02.1--Mix Design. Flowable fill is a mixture of Portland cement, fly ash, fine aggregate, air entraining admixture and/or high air generators and water. Flowable fill contains a low cementitious content for reduced strength development.

The consistency of the fresh mixture shall be that of a thin slurry. It shall be tested by filling an open-ended three-inch diameter by six-inches high cylinder to the top. With the mixture in the cylinder, immediately pull straight up. The correct consistency of the mixture will produce an approximate eight-inch diameter circular-type spread with no segregation. Adjustments of the proportions of fine aggregate and/or water may be made to achieve proper solid suspension and optimum flowability; however, the theoretical yield shall be maintained at one cubic yard for the given batch weights.

The Contractor shall submit mix designs for flowable fill to the Engineer to be verified by the Materials Division. The following table is a guide for proportioning flowable fill.

Material	Amount
Cement Type I	75 - 150 lbs/yd ³
Fly Ash	150 - 600 lbs/yd ³
Fine Aggregate	*
Water	**
Air [†]	15 - 35%
28 Day Compressive Strength [†]	Minimum 125 psi
Unit Weight, Wet [†]	90 - 110 lbs/ft ³

* Fine Aggregate proportioned to yield one cubic yard as verified by unit weight.

** Mix designs shall produce a consistency that will result in a flowable self-leveling product at time of placement.

† The requirements for percent air, compressive strength and unit weight are for Laboratory designs only and are not intended for jobsite acceptance requirements. An accepted air-generating admixture shall be used when no settlement is required.

631.02.2--Acceptance of Mix. The acceptance of the mix design shall be based on primary properties that include compressive strength, air content, hardening time, flowability, yield and settlement. This test data shall be submitted with the mix design. Continued use and acceptance, which will be based on the performance of the mix placed, will be at the discretion of the Engineer.

631.02.3--Manufacturing. Flowable fill will be manufactured at plants in accordance with Section 804.

631.03--Construction Requirements. Prior to placing flowable fill, each end of the structure shall be plugged leaving an opening at each end no larger than necessary to accommodate the filling equipment. Flowable fill shall be discharged from the mixer by any reasonable means into the area to be filled. Unless otherwise approved by the Engineer, filling will begin on the downstream end of the structure and continue until no further material will enter the structure. The flowable fill will then be continued from the upstream end of the structure.

631.04--Method of Measurement. Flowable fill will be measured by the cubic yard which will be determined by calculating yield. The yield will be calculated by dividing the actual batch weights of each load by the unit weight of the mix, which will be determined by testing the first load placed on each production day.

631.05--Basis of Payment. Flowable fill, measured as prescribed above, will be paid for at the contract unit price per cubic yard, which price shall be full compensation for furnishing all labor, equipment, tools and materials to complete

the work.

Payment will be made under:

631-A: Flowable Fill

- per cubic yard

SECTION 634 - TRAFFIC SIGNAL SYSTEMS -- GENERAL

634.01--Description.

634.01.1--General. This section together with the pay item sections covering individual components and the contract plans are intended to describe and include materials and work necessary for completion of traffic signal installations. All work, materials, or methods which may be necessary for completion of the several units which are not specifically mentioned in these specifications or on the plans shall be furnished as incidental to the pay items of the contract and the cost included in the respective contract prices bid.

634.01.2--Scope of Work. Work shall consist of furnishing and installing, modifying, or removing loop detector assemblies, shielded cable, detector amplifiers, detector equipment boxes, traffic signals and equipment poles, traffic signal heads, pre-timed controllers, solid state traffic actuated controllers, traffic signal conduit, electric cable, electrical junction boxes, and all incidentals necessary for a complete traffic control signal system installed, tested, and connected.

Where an existing system is (1) required to be modified under the contract, (2) required to be substantially replaced with new equipment but some elements of the existing system are to be retained, or (3) when the entire system is to be replaced, the Contractor shall reuse, if and as required, certain existing materials in the revised system, or shall dismantle and remove, salvage, and stockpile existing materials not specified to remain, or shall abandon such materials, all as shown on the plans, as specified in the special provisions, or as directed by the Engineer. Unless materials designated to be abandoned are shown to become the property of the Contractor for removal and disposal, the term "abandoned" shall indicate abandoned by the Contractor and fully protected by the Contractor for dismantling and removal or other disposal by the State or local jurisdiction having authority.

Unless the contract contains an item of Clearing and Grubbing or Removal of Structures and Obstructions, all such reuse, salvaging and stockpiling, removing or abandoning, and protecting of existing materials shall be performed by the Contractor and the cost thereof absorbed in other items of work under the contract.

The installations shall be carried out in strict conformity with all requirements stated or implied on the plans and in the specifications, and upon completion shall present a neat and finished appearance. All work and materials shall be subject to inspection at all times.

The locations shown on plans are diagrammatical and subject to slight changes as the Engineer may direct. The Contractor shall submit four complete sets of plans upon completion of the work showing all buried cable locations, field wiring schemes and color coding, pavement crossings, etc., in relation to fixed objects. The Contractor shall record all locations on a day-to-day basis.

All work shall be performed in strict accordance with applicable requirements of The National Electrical Code, The Insulated Cable Engineers Association specifications, The National Electric Manufacturers Association recommendations, and requirements of the local utility supplying the electric energy.

634.02--Materials.

634.02.1--General. All materials shall be of the best quality and workmanship and shall be new and of the most advanced proven design available. Throughout the project all units of any one item shall be made by the same manufacturer, but not all the items are required to be made by the same manufacturer. Such items are detector equipment boxes, pre-timed controllers, solid state traffic actuated controllers, traffic signal and equipment poles, detector amplifiers, conventional traffic signal heads, and optically programmed traffic signal heads.

Reference to any name, make, or manufacturer's number for an article of material or equipment is intended to be descriptive, but not restrictive, and is intended to indicate the quality of materials that will be acceptable.

The Contractor may propose the use of other manufacturer's materials on a basis of equality for the purpose intended. Substitutes which may be offered will be subject in every respect to the requirements set forth, and the Contractor shall submit detailed specifications and descriptions of such materials which will be subject to approval by the Engineer.

634.02.2--Equipment List and Engineering Data. As an aid to the Contractor in the procurement of required materials and as an aid to the State in the process of monitoring acceptability of manufactured materials and products, the Contractor shall, unless waived in writing by the Engineer, submit to the Engineer a list of manufactured articles, units, components, and materials which the Contractor proposes to install. The list shall be accompanied by adequate engineering data, including essential shop drawings, schematic diagrams, etc. The list shall identify the manufacturer and contain the identifying number of other identifying descriptions of each item. The list shall also be accompanied by

such other engineering or performance data as specified in other applicable sections of the specifications and on the plans.

Five sets of the indicated data shall be submitted.

The Engineer will notify the Contractor in writing of the findings. Any approval given will be an indication that the Engineer has considered that the materials or products, if manufactured and furnished in accordance with the data submitted, could be certified by the manufacturer in accordance with the provisions and requirements of Subsection 106.04, and any approval given shall be subject to such subsection and other applicable provisions of the contract.

If during the process of review of the indicated data, the Engineer requires the Contractor to submit sample articles for review, the sample articles remain the property of the Contractor only if requested in writing at the time of submission. In such case the article will be subject to return to the Contractor upon request without cost to the State.

The equipment list and engineering data as indicated herein shall be submitted within 30 days following execution of the contract. Any required submission after the initial submission to the Engineer shall be made within 15 days following the Engineer's request. The time allowed for review and reporting of the Engineer's findings to the Contractor shall be 30 days from the time of receipt of the initial data or 15 days after receipt of required subsequent data or samples, whichever is the latter date.

634.02.3--Regulations and Code. Where not specifically stated in these specifications, all electrical equipment and workmanship shall conform to the applicable requirements of NEMA, ICEA-NEMA, EIA, IES, ITE, ASTM, UL, and the utility company supplying the current where applicable.

Where abbreviations are used in these specifications, such as, in the case of relays, etc., N.O. and N.C. meaning "Normally Open" and "Normally Closed" respectively, or other terms not clearly defined, the meaning shall be understood to be that defined or used by the trade in the respective regulatory specifications and codes.

634.02.4--Operations. The Contractor shall furnish all labor, tools, equipment, motive power, barriers, and related items required or necessary to perform the work under the contract in a careful safe manner, properly, and expeditiously.

The Contractor shall conduct the work at all times in such a manner as to insure the least possible inconvenience to public travel, and to property owners on the streets, alleys, and other public places where the construction is to be done.

If underground utilities are in place or are encountered during excavation or other

operations, all necessary protection from injury thereof shall be provided by the Contractor. In order to facilitate such protection, it shall be the responsibility of the Contractor to solicit the assistance and cooperation of the owners of any utility or structure which may be in conflict with any of the Contractor's operations, and the Contractor shall fully cooperate with such utility in accordance with the provisions and requirements of Subsection 107.18. The Contractor shall save the State harmless from any additional cost incurred because of injury or damage by Contractor operations to any utility or structure. The repairs of any utility must be satisfactory to the owners, and insofar as physical condition and presence of the repaired utility shall be satisfactory to the Engineer.

Unless otherwise specified in the contract, for any traffic signal system where an existing system is used to provide control of the movement of the traffic, the following shall be applicable:

- (a) No part of the new traffic control system, required under the contract for that location shall be activated for controlling the traffic until all elements of the system(s) required for that location are complete and have been tested for operational completeness and effectiveness, and until such time all existing traffic control facilities and services shall remain in operation;
- (b) No part of the existing facility(ies) shall be altered, dismantled or removed without the confirmed permission of the Engineer;
- (c) When it is necessary or the Contractor is permitted to relocate a component of existing signal facilities because of required construction operations, the Contractor shall first obtain approval of the Engineer for procedures proposed and shall make such temporary approved removals and relocations as are necessary because of required construction. The Contractor shall utilize existing materials, equipment, and facilities and/or install and extend as necessary to maintain the effectiveness of existing system with the minimum interruption permitted by the Engineer, all at no additional cost to the State;
- (d) The State or local agency will continue operation and maintenance of existing traffic signals, will furnish electrical power for operation of the existing facilities, and will repair or replace facilities damaged by public traffic.

However, at such time the Contractor relocates any component of an existing traffic signal installation as required in the paragraph (c) above, the responsibility for maintenance and repair of all traffic signal installations located within the project limits shall become that of the Contractor. The State or local agency will continue to furnish electrical

power for operation of the traffic signals.

When notified of needed maintenance or repair, the Contractor shall respond within the hour to restore service or provide for other qualified repair personnel to restore service. In addition, the Contractor shall immediately notify the Engineer of action taken.

The Engineer in conjunction with the Traffic Engineering Division may, depending upon the level of service, waive the required one-hour response.

The Contractor shall provide the Engineer with the names and telephone numbers of those responsible for maintenance of the existing and new signals. The Contractor shall have at least one person who can be contacted 24 hours a day;

- (e) Where damage is caused by the Contractor's operations, the Contractor shall at no additional cost to the State, repair or replace damaged facilities promptly in accordance with these specifications. Should the Contractor fail to perform the required repairs or replacements immediately, the State or local authority may at its discretion provide manual temporary traffic control services. Such repairs or replacements will be deducted from moneys due or to become due the Contractor;
- (f) It shall be the Contractor's responsibility to hood or otherwise cover or make ineffective to the satisfaction of the Engineer all signs, signal heads, and messages, including those for control of pedestrian traffic, of the work being constructed until completion of all of the work in the system and the Engineer has given permission to activate the new system for control of traffic and deactivate the existing system; and
- (g) The provisions herein contained for the deactivation of an existing system and the activation of a new system shall be applicable to all types of existing systems whether they are stop-sign controlled, pre-timed signal controlled, traffic actuated signal controlled, or any combination of controls.
- (h) Traffic signal timings must be set in compliance with Department Standards. In order to obtain time settings not shown on the plans, the Contractor shall notify the Engineer at least one week in advance of the need for setting the timings. No timings shall be used that have not been provided by the Engineer. A written record of the timings shall be left in the cabinet.

The Contractor shall make arrangements for power necessary to perform all work required under the contract.

The existing electric power supply, if any, provided by the State or local authority for the operation of the existing signal system at that location will continue to be furnished by the State or local authority for the operation of the existing facility until removal is authorized, and for the operation of the new system during the Satisfactory Performance Period required in Subsection 634.03.3. It shall be the Contractor's responsibility, without additional cost to the State, to make such connections, if any, as are necessary to connect to the existing electric power supply of the State or local authority for power to operate the system during the satisfactory performance period.

It shall be the Contractor's responsibility, without additional cost to the State, to make the necessary arrangements with the local power company to provide electrical service for any installation that does not have an existing power service. The Contractor shall pay for all deposits, hook-up charges, or other initial fees required by the power company. The State or local authority will pay the monthly service bill for the new installation.

The Contractor shall require the manufacturer to begin the warranty or guaranty period of warranties and guaranties required in Subsection 106.01.2 not sooner than 30 days before the article, unit, component, materials, or product is installed in the work and the signal system is complete, or the Contractor shall furnish the Engineer, in a form approved by the Department, similar warranties and guaranties as covenants under the contract and contract bond for an extended period of time equal to the lapse of time between the beginning date of the manufacturer's warranty or guaranty and the date occurring 30 days prior to the date of installation and satisfactory performance in the work.

634.02.5--Prequalification. In addition to meeting the appropriate specifications, if the Contractor proposes to use traffic signal controllers, time switches, conflict monitors, load switches, time base coordinators, signal heads, or detector amplifiers that are not currently used by the Department, the equipment manufacturer shall provide the Department with certification that at least 50 units of the model proposed have been in field use for at least two years by at least five organizations. This certification shall include the names of the organizations using the equipment, the responsible persons in the organizations, and the particular locations where the equipment is used. These locations shall not include those where prototype equipment is installed or those where the equipment is being field tested. The State reserves the right of approval for use until these organizations are contacted. If the equipment has not functioned properly in the field, the State may deny approval for use.

The equipment proposed shall meet or exceed the latest NEMA standards for the particular items. The manufacturer shall provide certification that these standards are met. In addition, copies of the laboratory reports and the test procedures shall be provided to determine that the equipment meets the environmental standards set forth by NEMA. Once this equipment is approved for use and then installed

by the Contractor and final acceptance is made by the Department, it shall be considered to be under field testing for a period of at least one year. During this time the Department will maintain the equipment and keep accurate records of any malfunctions that occur. At the completion of this test period, the Department will determine if the equipment will be suitable for use on future projects. The manufacturer shall also assure the Department that a factory authorized technician will be readily available to assist in installation and maintenance of the equipment. The name or names of the technicians shall be provided to the Department prior to final acceptance.

634.03--Construction Requirements.

634.03.1--General. The installation of the various types of equipment shall be carried out in compliance with the requirements stated in the sections herein covering the individual components required to complete the traffic signal system and in conformity with the details shown on the plans. Upon completion of the work all equipment shall present a neat and workmanlike finished appearance. Upon completion of the work and before final payment is made, the Contractor shall remove all excess materials from excavation, reshape and resod any portion of the highway which may have been disturbed by construction operations, and leave the project in a neat and sightly condition.

634.03.2--Performance Tests.

634.03.2.1--Circuit Continuity and Short Circuit. All circuits shall be tested to determine that they are continuous and free from short circuits.

634.03.2.2--Freedom from Unspecified Grounds. All circuits shall be tested to see that they are free from unauthorized grounds.

634.03.2.3--Resistance to Ground. All non-grounded conductors shall be tested with a 1000 volt DC megger. The insulation resistance shall be a minimum of 10 megohms.

634.03.2.4--Ground Resistance. The resistance to ground shall not be more than 25 ohms. The above tests shall be in addition to specified tests required for the individual items.

634.03.3--Satisfactory Performance Period. After satisfactory completion of the above tests, the traffic signal installation shall be placed in operation. Final acceptance will not be made until each traffic signal installation has operated satisfactorily for at least 30 consecutive days. During each 30 day performance period, if failure should occur in any of the mechanical or electrical equipment in the system other than minor readily replaceable components such as light bulbs, etc., the cause for the failure shall be determined, the necessary replacements made, and the system operated satisfactorily for an additional 30 consecutive

days. Contract time will continue to be evaluated during the satisfactory performance period(s).

When the Contractor has satisfactorily completed all items of work on the project including the satisfactory performance period, the Engineer will make a final inspection of the completed work in accordance with Subsection 105.16.2. If the completed work is found to be satisfactory, the Director will release the Contractor from maintenance.

Final acceptance is also subject to the guaranty provisions of Subsections 106.01, 634.02.4 and other provisions of the contract.

634.03.4--Training Period. Except as provided in the following paragraph, the Contractor shall provide training on the control equipment to be installed within the scope of this contract. All training shall be conducted by the Contractor at no addition cost to the State. The Contractor shall provide a total of 20 hours of operational and maintenance training.

If, in the opinion of the Engineer the training period for the particular equipment to be supplied is not necessary, then the requirement of a training period will be waived.

634.03.4.1--General Requirements. Training in system and equipment operation will be provided for State or local agency engineering personnel. Maintenance training for the intersection control equipment will be provided for State or local agency maintenance personnel. The training of instructors and preparation and furnishing of supplemental text material and training aids shall be the responsibility of the supplier. All training shall take place in facilities provided by the Contractor and approved by the Engineer. The Contractor shall be responsible for providing the training. The training shall be conducted by personnel of the Contractor or the equipment supplier or manufacturer.

634.03.4.2--Scope of Training.

634.03.4.2.1--Operation Training. The objective of this training program is to provide engineering and management familiarization with the operation of the traffic control system and to provide a capability for proper implementation and use of the system. The instruction shall include, but shall not be limited to, system theory and general equipment operation.

634.03.4.2.2--Maintenance Training. The objective of this training is to familiarize the maintenance personnel with the technical operation, maintenance procedures, and trouble-shooting procedures for the installed equipment. The instruction shall include, but shall not be limited to, maintenance procedures and operation covering intersection controllers.

634.03.4.2.3--Scheduling of Training. Scheduling of training sessions shall be coordinated with the Engineer. Operation training and maintenance training shall not be scheduled concurrently.

634.03.4.2.4--Personnel to be Trained. The Contractor shall be prepared to provide training for personnel appointed by the Engineer.

SECTION 635 - VEHICLE LOOP ASSEMBLIES

635.01--Description. This work consists of furnishing all component materials required to form complete independent vehicle loop assemblies of the types specified and assembling, constructing, erecting, and installing same in conformity with these specifications to insure properly operating units in accordance with the designs and at the locations shown on the plans or as directed.

635.02--Materials. Materials used in this construction shall conform to the requirements of Subsection 722.18.

635.03--Construction Requirements.

635.03.1--Loop Slots. Loop wire shall be installed in saw cuts in the roadway made by a diamond or abrasive power saw. The slot width and depth shall be as indicated on the plans; however, in all cases the slot shall be of sufficient depth to provide for a minimum of one inch cover between the top of the loop wires and the roadway surface.

The saw cuts shall be overlapped so that the slot has full depth at all corners. All corners where loop wires turn shall be diagonally cut so that there are no jagged edges or protrusions which may damage the wire.

Prior to installation of the wire, the saw cuts shall be cleaned and dried. There shall be no cutting dust, grit, oil, free water or other contaminants in the saw cut.

635.03.2--Wire Installation. The loop wire shall not have any cuts, nicks, abrasions or breaks in the insulation before or after installation in the slot. Any wire having defects in the insulation shall be replaced.

Loop wire and lead-in to the pull box or loop detector shall be one continuous length of wire with no splices.

Loop lead-in from the curb or edge of pavement to the pull box shall be installed in conduit of the size and type as indicated on the plans. The loop lead-in for each loop shall be run in separate saw cuts from the loop to the pull box.

The two loop lead-in wires shall be twisted two to five turns per foot from the

loop to the point of termination.

Loop lead-in wires or shielded cable terminating in controller cabinets, detector cabinets or pull boxes shall be uniquely identified by an insulated, waterproof tag. Identification shall indicate the lane and the direction of traffic it detects.

Lead-in as intended in this section is the two loop wires from the loop to the shielded cable.

Each loop shall have a shielded cable from the pull box to the controller cabinet or detector equipment box, unless otherwise specified and/or directed by the Engineer. There shall be no splices in the shielded cable unless otherwise directed by the Engineer or shown on the plans. Shielded cable shall be as specified in Section 636.

The wire shall be placed in the bottom of the slot so that there are no kinks, curls, straining or stretching of the insulation. Subsequent turns of the loop shall be placed to assure vertical stacking of the wires.

Special care shall be taken in seating the wires so that the insulation will not be broken or abraded. No sharp tools such as screwdriver or metal object shall be used for this operation.

Loops shall have sufficient turns of loop wire to conform to the following tables unless the manufacturer of the loop detector being used specifically recommends different inductance values. Loop location and configuration shall be as shown on the plans unless otherwise directed.

LOOP INDUCTANCE TABLE
6-Foot Loop Width

Loop Size feet	Inductance, microhenries			
	1 Turn	2 Turn	3 Turn	4 Turn
6 x 4	8	25	56	100
6 x 6	10	31	70	124
6 x 10	14	43	96	171
6 x 15	19	58	129	229
6 x 20	24	72	161	286
6 x 25	29	87	194	
6 x 30	34	101	226	
6 x 35	38	116	259	
6 x 40	43	130		
6 x 45	48	145		
6 x 50	53	159		
6 x 55	58	173		
6 x 60	63	188		
6 x 65	67	202		
6 x 70	72	217		
6 x 75	77	231		
6 x 80	82	246		
6 x 85	87	260		
6 x 90	91	275		
6 x 95	96	289		
6 x 100	101	303		

LEAD-IN VS. LENGTH INDUCTANCE

Length Feet	Inductance microhenries
50	14
100	26
150	38
200	50
250	62
300	74
350	85
400	97
450	109
500	121
550	133
600	145
650	158
700	171
750	184

Total Inductance, loop and lead-in inductance, shall be from 135 to 500 microhenries.

After placing the wire in the slot it shall be rechecked for slack, raised portions and/or tightness and to assure that the wires are depressed to the bottom of the slot.

635.03.3--Sealing the Saw Cut. All saw cuts with the wire installed shall be inspected and approved by the Engineer before the sealer is installed.

The Contractor shall install the sealer in strict adherence to the manufacturers recommendation and these specifications.

No sealer shall be installed during inclement weather or under any condition which might introduce moisture into the saw slots.

The viscosity of the sealer shall be such that it can be readily poured into the slot, completely surround the wires, displace all air and fill the slot so that the sealer is flush with the roadway surface. The finished sealed slot shall be waterproof and present a neat workmanlike appearance.

The sealer shall be sufficiently hardened before allowing traffic on it.

635.03.4--Testing. After the loop and lead-in have been assembled in place and before sealing the saw slot, a continuity check and a resistance check on the loop to ground shall be made. Resistance to ground shall be not less than 10 megohms. This same test shall be made after the slot is sealed. An inductance test shall also be made to insure that the required inductance values are achieved.

635.04--Method of Measurement. Vehicle loop assembly will be measured by the linear foot computed horizontally along the saw slot in which the loop wire is installed and will not include the loop lead-in to the pull box.

Probe point detection unit will be measured as paired units per each which measurement shall include all items necessary to complete the installation.

635.05--Basis of Payment. Vehicle loop assembly & probe point detection unit, measured as provided above, will be paid for at the contract unit price per linear foot of loop or per each paired probe point detection unit, which price shall be full compensation for furnishing all materials; for all drilling and/or sawing; installing; sealing; connecting lead-in; testing; and for all equipment, tools, labor and incidentals necessary to complete the work.

Payment will be made under:

635-A: Vehicle Loop Assembly	- per linear foot
635-B: Probe Point Detection Unit, Paired	- per each

SECTION 636 - SHIELDED CABLE

636.01--Description. This work consists of furnishing and installing shielded cable from the two wire loop lead-in to the detector amplifier at the locations as shown on the plans or as directed.

636.02--Materials. Materials used in this construction shall conform to the following requirements.

636.02.1--Shielded Cable. Shielded cable shall conform to the requirements of loop detector lead-in cable in Subsection 722.03.

636.02.2--Conduit. Conduit required for installation of the shielded cable shall be in accordance with Section 668.

636.03--Construction Requirements.

636.03.1--Construction Details. Shielded cable from the loop lead-in to the detector amplifier shall be of one continuous length and installed in conduit or aerially supported on messenger cable and spliced to the loop lead-in wires in the pull boxes.

All splices in pull boxes must be carefully made to insure constant low resistance and must be insulated by means of a waterproof splice. The loop lead-in shall be spliced to the shielded cable using butt splice crimp connectors. The connectors should then be coated with a waterproof adhesive. Each splice should then be separately wrapped with an all weather electrical tape and a self bonding electrical tape. Finally, both splices should be wrapped together with an all weather electric tape and coated with a waterproof adhesive.

Shielded cable shall be solidly fastened with ring lugs to the terminal strip in the detector equipment cabinet or controller cabinet. Both ends of the shielded drain wire shall be cut off flush and waterproofed so as to not come in contact with the pull box or ground.

All work performed shall present a neat and workmanlike appearance.

Installation of shielded cable in conduit or aerial shall comply with applicable provisions of Section 666.

636.03.2--Tests. After installing shielded cable lead-in and connecting to loop lead-in the same tests as required under Subsection 635.03.4 shall be performed.

636.04--Method of Measurement. Shielded cable will be measured by the linear foot. The measurement shall be computed horizontally along the conduit or aerially along the messenger cable in or on which the shielded cable is

installed. No extra length will be allowed for risers to equipment cabinets, controller cabinets or messenger cable. The points for the measurement of length will be considered specifically as the center of the pull boxes, equipment or controller cabinets, or messenger cable support structure.

636.05--Basis of Payment. Shielded cable, measured as provided above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for furnishing all materials, for all installing, connecting and testing, and for all equipment, tools, labor and incidentals necessary to complete the work.

Payment will be made under:

636-A: Shielded Cable * - per linear foot

- * For shielded cable other than AWG #14, 2-conductor, the pay item will indicate the AWG and/or number of conductors.

SECTION 637 - EQUIPMENT CABINETS

637.01--Description. This work consists of furnishing and installing equipment cabinets of the type and at the locations shown on the plans, or as required, all in accordance with the requirements of these specifications and the design details shown on the plans.

637.02--Materials. Materials shall meet the requirements of Subsection 722.13.

637.03--Construction Requirements. The installation as a whole shall be carried out in conformance with the requirements of these specifications and as shown on the plans, or as directed and shall present a neat and workmanlike appearance. Safe construction and installation practices, meeting the requirements of the N.E.C. and local requirements shall be maintained.

637.04--Method of Measurement. Equipment cabinet at each required location will be measured as unit quantities per each. Such measurement shall include all items necessary to complete the installation.

637.05--Basis of Payment. Equipment cabinet, measured as provided above, will be paid for at the contract unit price per each, which price shall be full compensation for furnishing all materials, for all construction, erecting, installing, connection; for mounting attachments, shelves, lock keys, breathers, drains, ground wire, terminal strips, surge protection, circuit breakers, and for all equipment, tools, labor and incidentals necessary to complete the work.

Payment will be made under:

SECTION 638 - LOOP DETECTOR AMPLIFIERS

638.01--Description. This work consists of furnishing loop detector amplifier units complete with all equipment necessary for installation in the detector equipment box or controller and connection to the loop shielded cable lead-in and detector supply cable.

When specified, this work shall also consist of furnishing infrared vehicle detector units with all equipment necessary for installation for side of pole mounting and connection to signal cable.

638.02--Materials. Loop detector amplifiers shall meet the requirements of Subsection 722.19.

Infrared vehicle detectors shall meet the requirements of Subsection 722.20.

638.03--Construction Requirements.

638.03.1--Construction Details. The installation of each loop detector amplifier unit shall consist of mounting in the cabinet and connecting to input and output cable as indicated on the plans and/or in these specifications or as directed and shall present a neat and workmanlike appearance.

Infrared vehicle detector units shall be side-of-pole mounted in such a manner to align infrared output to position shown on plans.

638.03.2--Tests. The Contractor shall demonstrate to the Engineer's satisfaction the operation of the detector amplifier in all modes.

638.04--Method of Measurement. Loop detector amplifier and infrared vehicle detector will be measured as unit quantities. Such measurement shall include all items necessary to complete the installation.

638.05--Basis of Payment. Loop detector amplifier and infrared vehicle detector, measured as provided above, will be paid for at the contract unit price per each, which price shall be full compensation for furnishing all materials, for all construction, erecting, installing, connecting, testing, and for all equipment, tools, labor, and incidentals necessary to complete the work.

Payment will be made under:

638-A: Loop Detector Amplifier, ____ Channel
or

Loop Detector Amplifier, Card Rack Mounted ____ Channel - per each

638-B: Infrared Vehicle Detector, Width of Lens - per each

SECTION 639 - TRAFFIC SIGNAL EQUIPMENT POLES

639.01--Description. This work consists of furnishing all component materials required to form completed independent signal equipment poles and extensions of the types specified and assembling, constructing, erecting and installing same in conformity with these specifications to ensure support poles in accordance with the design(s) and at the lines and grades shown on the plans or as directed.

639.02--Materials. The materials used in this construction shall conform with the general requirements of these specifications and the specific requirements set out hereunder.

639.02.1--Poles. Poles shall meet the requirements of Subsection 722.02.

639.02.2--Mast Arms. Mast arms shall be steel meeting the requirements of Subsection 722.16.

639.02.3--Foundations. Cast-in-place foundations for concrete, steel, and/or aluminum shafts shall be as specified on plans, and shall be cast of reinforced Class "B" Concrete conforming to the requirements of Sections 601 and 602. Anchor bolts, washers, and hexagon bolts for use in the foundation shall conform to Subsections 722.11 and 722.12. The anchor bolt shall be galvanized only through the threaded section and a minimum of six inches below the top of the concrete foundation. The foundation bolts shall be set in the concrete foundation to fit the bolt circle of each type of pole. Conduit for electric cable shall comply with the requirements for such materials as set out in Subsection 722.05.

639.02.4--Shaft Extension. The traffic signal equipment pole shaft extension shall meet the requirements of the plan.

639.03--Construction Requirements.

639.03.1--Foundations. Excavation for concrete foundations or butts shall be opened vertically in accordance with the methods of Section 206 with a tolerance of plus two inches from neat lines and grades as shown on the plans or required by local conditions. Adjacent earth shall be compacted sufficiently to withstand the loadings set out under Subsection 722.02.1.3. Before placing concrete, the Contractor shall place reinforcing bars, conduit and anchor bolts, all in accordance with plan details, and held rigidly in place by approved methods. Concrete foundations shall be formed, cast and cured in accordance with the provisions of Section 601. The top surface shall be finished smooth, and sloped

to drain.

639.03.2--Setting and Aligning Poles. Poles anchored to the concrete foundation or with precast butts shall have sufficient rake so as to assume a vertical position when the load is applied. Poles with precast butt shall be wet-tamped in place with crushed aggregate, concrete or satisfactory cement stabilized soil, as directed. Poles set on concrete foundations may use leveling nuts to align poles. After alignment of pole on the concrete foundation is completed, the entire area between the bottom of the pole and the top of the concrete foundation shall be filled with grout meeting the requirements of Subsection 714.11. Careful aligning of the poles shall be considered a most essential feature of the installation of the assembly and shall be as nearly perfect as practicable.

639.04--Method of Measurement. Traffic signal equipment pole of the type specified will be measured as unit quantities per each. Such measurement shall include foundation, mast arms and all other incidentals necessary to complete the work.

Traffic signal equipment pole shaft extension of the type specified will be measured as a unit quantity per each. Such measurements shall include the pole attachment, shaft, and all other mounting attachments necessary to extend a shaft as required in the plans.

639.05--Basis of Payment. Traffic signal equipment pole and traffic signal equipment pole shaft extension of the type specified, measured as provided in above, will be paid for at the contract unit price per each and pole extension, which price shall be full compensation for furnishing all materials, for excavating, backfilling, replacing sod, and for all constructing, placing, curing, erecting, installing, connecting and testing; for foundations, poles, pole bases, mast arms, caps, covers, ground wire, ground rods, hardware and for all equipment, tools, labor and incidentals necessary to complete the work.

Payment will be made under:

639-A: Traffic Signal Equipment Pole, Type _____ - per each

639-B: Traffic Signal Equipment Pole Shaft Extension, Description - per each

SECTION 640 - TRAFFIC SIGNAL HEADS

640.01--Description. This work consists of furnishing traffic signal heads of the type specified and installing them in accordance with these specifications and the details shown on the plans or as directed.

640.02--Materials. Materials furnished for traffic signal head installation shall conform to the requirements of Subsection 722.14.

640.03--Construction Requirements.

640.03.1--Construction Details. Traffic signal heads shall be mounted on the messenger cable, mast arms, or pedestal poles and connected to the signal supply cable as indicated on the plans and as required in these specifications.

Initial location and aligning of heads shall be performed as indicated on plans. Final positioning and aligning shall be performed by field observation to obtain optimum visibility of the signal faces by approach traffic.

Ample slack shall be left in the signal supply cable to provide for field adjustment of head alignment and to form drip loops after heads are in final position.

The new signal heads shall hang over the traffic lanes for no more than two weeks before the traffic signal installation is turned on. During this time the heads shall be completely covered to the satisfaction of the Engineer so as to not conflict with the existing signal heads or be a distraction to the motorists.

640.04--Method of Measurement. Traffic signal head of the types specified on the plans will be measured as a unit quantity per each, such measurement being inclusive of the housing, mounting attachments, lens, lamps, reflectors, visors, sockets, socket wiring, back plates where specified, turn-signal signs, tether cable, and other necessary incidentals and being inclusive of all materials, work and services necessary for a properly constructed, tested and operable unit complete in place and accepted.

640.05--Basis of Payment. Traffic signal head of the types specified, measured as prescribed above, will be paid for at the contract unit price per each, which price shall be full compensation for furnishing housing, mounting attachments, lens, lamps, reflectors, visors, sockets, socket wiring, back plates where specified, turn-signal signs, tether cable, and all other materials; for installing, mounting, connecting, aligning, testing, and for all equipment, labor, tools, and incidentals necessary to complete the work.

Payment will be made under:

640-A: Traffic Signal Head, Type _____ - per each

SECTION 642 - SOLID STATE TRAFFIC ACTUATED CONTROLLERS

642.01--Description. This work consists of furnishing all component materials required to form complete and independent solid state traffic actuated controller unit(s) of the type(s) specified and assembling, constructing, erecting, and installing same in conformity with these specifications, to insure properly operating unit(s) in accordance with the design(s) and at the locations, lines and grades shown on the plans or directed.

642.02--Materials.

642.02.1--Controller Units. The purpose of this subsection is to describe the minimum acceptable design and operating requirements for a solid state two to eight phase traffic signal controller that utilizes digital concepts for all interval settings and timing.

All definitions shall be in accordance with NEMA Standards Publication TS 1-1989 Section 1.

Programming of controller unit variables shall be by way of a front panel keyboard and display. The controller unit shall prevent the alteration of the keyboard set variables. The controller shall use English language menus.

The units shall be shipped with a universal "Access" code. This code shall also be user programmable via the keyboard.

All variables and variable names shall be displayed for visual verification at the time of data entry.

The controller unit shall maintain user programmable variables in EEPROM memory to assure continued safe and efficient controller unit operation in the event of power loss. No batteries are required except for models with coordination and time base clocks which utilize RAM for continuous clock operation.

The controller unit shall perform all of its functions within the environmental conditions specified in NEMA Standards TS 1-1989 Section 2.

Input-output interface of the controller shall meet the following requirements:

- (1) The electrical limits of inputs and outputs shall meet the requirements of NEMA Standards TS 1-1989 Section 13.2.
- (2) Input functions and number of terminals shall meet the requirements of NEMA Standard TS 1-1989 Section 13.3.

- (3) Output functions and number of terminals shall meet the requirements of NEMA Standards TS 1-1989 Section 13.4.
- (4) Connectors and connections shall conform to NEMA Standard TS 1-1989 Section 13.5.
- (5) An RS-232C interface and connector shall be provided for interconnecting to a printer, another like controller unit, a local personal computer, or a remote personal computer through an external modem.

The controller unit shall be capable of transmitting ASCII coded information (data, letters, headings, etc.) to an 80 column or larger printer. The printer must be RS232C compatible, be able to receive ASCII coded serial data at 1200 baud, eight data bits and odd parity.

The controller unit timing and operational data shall be individually transmitted to the printer. The printout shall be in a format easily understood by a person familiar with traffic engineering terminology. The unit to printer transmissions shall not interrupt normal controller unit operation.

The controller unit timing and operational data shall be individually transmitted to/from another like controller unit.

The controller unit timing and operational data shall be individually transmitted to/from a personal computer running the appropriate software.

The controller unit active status, e.g. Traffic Timers, Coord Timers, Preempt Timers, and Time Base Current, shall be individually transmitted to the personal computer running the appropriate software.

The controller unit report logs shall be individually transmitted to the personal computer running the appropriate software.

The controller unit shall allow the user access from a remote personal computer and also from a local laptop personal computer. The user shall be able to communicate with the intersection controller, as described, in order to monitor current operation; record and analyze traffic conditions by time and pattern; and modify, upload and download any controller program or timing parameter.

Provision for a separate communications port shall be made for purposes of using the controller in a system's environment. In the event the controller is used as a "system controller", no changes to the controller shall be allowed, other than the addition of an internal communications module (modem board), and the unit shall not require re-programming of timing data.

All controllers shall be modular and completely solid state in function. Gears,

cam shafts, motors, reed switches, etc., shall not be used for any functions within the controller.

Timing shall be digital; analog timing is prohibited.

It shall not be permissible to connect two controllers together for the purpose of increasing their control capacity. Special equipment not specifically covered by this specification shall be electronic and solid state in construction.

The power supply shall be easily removable from the main frame with the use of only common tools. The power supply shall have overvoltage and overcurrent protection for all DC plus and DC minus voltages. The power supply shall be readily accessible.

All controllers shall be provided with frames fully wired for maximum expansibility capable of operating up to eight (8) phases.

The controller frame shall be of sturdy construction and shall be equipped with card guides and edge card connectors to receive the various plug-in modules. A minimum of two card guides, one for the top and one for the bottom, per module slot shall be furnished with the frame. The modules shall be interconnected by means of a motherboard assembly or other approved method.

Modules shall be positively fastened to the frame and shall require no tools to remove or replace. Each module which has a front panel shall be removable and replaceable without the necessity of removing adjacent modules. Controllers with module mounted subpanels shall be provided with blank subpanels for all unused module positions.

Input-output connections shall be considered as part of the controller frame.

The controller frame shall include all modules that are required to make the controller assembly operate as per these specifications. All controller modules supplied shall provide the design maximum complement of circuits. Partially completed modules will not be accepted.

The controller frame shall be furnished completely enclosed in a durable sheet aluminum, or approved alternate, housing with a durable finish. The housing shall be designed to adequately dissipate the heat generated by the controller circuitry. The controller frame shall have the serial number permanently stamped, engraved or printed on the outside of the housing.

The design of the controller unit shall be such that electronic components are logically grouped and arranged on plug-in modules or printed circuit assemblies.

The printed circuit boards shall be constructed in accordance with TS 1-1989

Section 14.2.3. The identification of the component parts shall be etched or silkscreened on the circuit boards.

The controller shall provide the proper intervals and interval sequences as required in the specifications and as shown on the plans. The controller shall be able to skip any traffic phase for which a vehicle or pedestrian call does not exist.

The controller shall provide for the setting of each interval, portion of interval or function by means of pushbuttons. The controller shall be calibrated in seconds and tenths of seconds. Setting of timing and function values shall be accomplished without use of special tools or wiring changes.

There shall be provisions for position indication of all parameters. Display shall be self-evident to permit verification of stored information. Steps required to use pushbutton timing controls shall follow a natural sequence, misleading information shall not be displayed at any time. Controls shall be labeled and completely identified as to what their function and use is.

The interval and function controls shall be located on the front of the controller and shall be properly designated as to the function each control performs.

The required intervals, portions of intervals, and functions for each phase of operation shall be as listed in the table below:

<u>Interval (Function)</u>	<u>Minimum Range in Seconds</u>	<u>Increment in Seconds</u>
Minimum, Initial	0 - 99	1
Extension, Passage	0 - 9.9	0.1
Maximum	0 - 99	1
Maximum 2	0 - 99	1
Yellow Clearance	0 - 9.9	0.1
Red Clearance	0 - 9.9	0.1
Walk	0 - 99	1
Pedestrian Clearance	0 - 99	1
Added Initial	0 - 9.9	0.1
	per actuation	
Maximum Initial	0 - 99	1
Minimum Gap	0 - 9.9	0.1
Time to Reduce	0 - 99	1
Time Before Reduction	0 - 99	1

In addition to the time settings and functions listed and the functions required in NEMA Standards TS 1 - 1985 Section 14.3.2, the following functions shall be provided:

- (1) Per phase response to NA 1 and NA 2 inputs.
- (2) A per phase vehicle call
- (3) A per phase pedestrian call

Functions and indications required on a per ring basis shall conform to NEMA Standards TS 1-1989 Section 14.3.3.

Functions and indications required on a per unit basis shall conform to NEMA Standards TS 1-1989 Section 14.3.4. In addition, the following per unit functions shall be provided:

- (1) Start-up Flash - An adjustable time period of 0 to 99 seconds shall be provided for flashing operation prior to the initialization routine.
- (2) Remote Flash - An input shall be provided to call for remote flash. Upon activation of the input the controller shall service all waiting calls before proceeding to the flash entry phases. After servicing these phases, the controller shall begin flashing operation.

The priority of input functions shall be in the following order:

(1) Power up	(7) Remote flash
(2) External start	(8) Manual control enable
(3) Phase omit	(9) Ring force off
(4) Pedestrian omit	(10) Phase hold
(5) Interval advance	(11) Pedestrian recycle
(6) Stop Time	

The controller unit displays shall be easy to read LCD that operates within the temperature ranges of the NEMA Standards TS 1-1989 Section 2.

The controller unit shall utilize multi-segment alpha/numeric characters for displaying programming information and controller timing. The display shall be clearly readable in ambient light including the cabinet light or full sunlight from a distance of four feet at a 45 degree angle.

The display shall have two modes of operation. The first mode shall be a dynamic mode, it shall show the current timing interval and the time remaining in that interval. The second mode shall be a program mode, it shall show the interval and time/date programmed and/or being programmed.

The unit shall provide the ability to simultaneously display the variable and its value for all applicable entries, i.e., all eight phases of passage time. The following per phase indicators shall be provided:

(1) Phase on	(5) Phase Red, Yellow, Green,
(2) Phase next	Walk, and Don't Walk
(3) Phase vehicle call	(6) Number of cars waiting
(4) Phase pedestrian call	(7) Vehicle & pedestrian recall

Per ring function indications shall be provided as follows:

(1) Walk	(11) Red Rest
(2) Don't walk	(12) Added Initial
(3) Min. Green	(13) Time Before Reduction
(4) Passage	(14) Time to Reduce
(5) Max. Out	(15) Max 1
(6) Gap Out	(16) Max 2
(7) Force off	(17) Green dwell
(8) Green dwell	(18) Stop Time
(9) Yellow	(19) Hold
(10) Red Clear	

In addition to the features required in NEMA Standards 1-1983, the following per phase features shall be provided:

- (1) Cars before reduction
- (2) Actuated rest-in-walk
- (3) Soft vehicle recall
- (4) Selective phase omit
- (5) Phase detector modifiers for stretch, delay and/or detector switching.

The following per unit features shall be provided:

- (1) Entry and exit phases for remote flash
- (2) Provides print out and unit to unit transfer

The controller unit shall contain a reserve data base of controller unit variables stored in Programmable Read Only Memory (PROM). It shall be possible for the operator to activate the reserve data base by loading it into memory through a simple procedure utilizing front panel controls only.

642.02.2--Load Switches and Flashers. The controller and cabinet assembly shall be provided with the number of external load switches required to provide the sequence called for on the plans.

The load switch sockets shall be wired for triple-signal load switches conforming to Section 5 of NEMA Standards Publication Number TS 1-1989. All load switch driver outputs coming out of the controller unit shall be on separate terminal points from the respective inputs to the load switches. These separate points shall be bussed for normal operation. All load switch outputs which may

be programmed for flashing or programmed for monitor connection shall be on separate terminal points from the respective inputs to the flash transfer relays or monitor inputs. These separate points shall be bussed for normal operation.

The flasher socket shall be wired for a Type 3 solid state flasher conforming to Section 8 of NEMA Standards Publication Number TS 1-1989. Flashing of main street load switch output indications shall be placed on one circuit and flashing for minor street load switch output indications shall be placed on the other circuit. It shall be possible to flash either the amber or red indication on any load switch outputs. It shall be possible to easily change the flash indication from the front side of the panel using simple tools without the need to unsolder or resolder connections.

Load switch and flasher bases shall be so designed and constructed as to receive all such devices which may be manufactured to the maximum size requirements permitted under the NEMA Standard Publication Number TS 1-1989.

All support(s) shall be provided so that, as a minimum, it is supporting the flasher and load switch of the maximum size at some point(s) between three inches and seven inches from the panel surface.

At least 90% of the area beneath the load switch or flasher shall be open to allow for free flow of air across the load switches or flasher. There shall be no obstruction within one inch above or below the units within the open area.

642.02.3--Conflict Monitor. The controller assembly shall be provided with a conflict monitor which shall cause the signals to go into flashing operation should a conflict in signal indications be sensed. The stop time input will be applied to the controller whenever the monitor causes the signals to go into flash. The conflict monitor shall conform to NEMA Standards TS 1-1989 Part 6. The conflict monitor provided shall contain the number of input channels necessary to monitor the maximum number of load switches possible in the controller cabinet terminal facilities.

642.02.4--Coordination/Time Base Program. Each controller unit shall be equipped with an internal program for coordination and time base control. The coordination shall also accept dial, split, and offset commands from hardware interconnected systems. The coordination program shall provide a minimum of 48 timing plans. Coordination settings and activity shall be monitored by the controller unit display.

Offset transition shall be by one of three methods:

- (1) Shortway transition, or
- (2) Infinite dwell transition, or
- (3) Dwell with interrupt transition

The coordination shall provide smooth transfer from free to coordinated and program to program operation.

The coordinator shall provide for selecting which phase(s) are to be coordinated. The coordinated phase(s) shall operate as non-actuated in the coordinated mode. The controller shall monitor the sync pulse so that it will revert to free operation when no sync pulse is received for three consecutive cycles.

The coordinator shall be capable of manual front panel selection of dial-split-offset combinations. Manual selection shall override interface commands. Manual sync of the pattern shall be controlled through the front panel.

The coordinator shall be capable of free operation. During this mode, all coordinator control of the controller operation will be removed. The coordinator shall recognize input requests that conflict with the internal coordination operation and automatically revert to free mode when the inputs are active. These remote inputs include stop time, manual control enable and preemption.

The internal coordinator shall provide techniques to guarantee that all unused time from the non-coord phase(s) in the background cycle shall be reallocated to the coord phase(s).

The coordinator shall provide for a controlled release (permissive period) to each of the non-coord phases in sequence. When a call is not present for the phase to be serviced next in sequence, the coordinator shall re-allocate that phase's time to the end of the coord phase. The time allocated to any actuated phase shall never exceed that programmed regardless of when it may appear in the background cycle because some other phase gapped out earlier than the limit set in the program.

Prior to the completion of the coord phase time and the beginning of the first permissive period, the coord phase pedestrian shall display the ped clear indication and dwell DONT WALK. This shall eliminate the need to provide ample time in each subsequent phase time for the coord phase ped clear. The coord phase pedestrian shall dwell DONT WALK until such time as the coord phase terminates and returns to green or the last permissive period in the cycle is complete without the coord phase terminating.

The user shall enter the coord phase(s), the phase times, and offsets. All timings shall be in seconds so there shall be no conversion from seconds to percent and vice versa. The yield points, permissive periods, and force off points shall be calculated internally.

The coordinator shall provide an adjustable time (split) for each phase for each of the timing plans. The phase time shall be adjustable from 1 to 99 seconds. For the coord phase(s) this shall become the minimum phase time and for the

actuated phases it shall become the maximum phase times.

The coordinator shall provide for operation modifiers to be selected for each actuated phases in each of the sixteen timing programs. The five modifiers shall be:

- (1) Minimum Vehicle Recall
- (2) Maximum Vehicle Recall
- (3) Pedestrian Recall
- (4) Maximum Vehicle Recall and Pedestrian Recall
- (5) Phase Omit

The coordinator shall provide a means to select one of the alternate sequences or the standard sequence as a function of the pattern, Dial/Split/Offset, in effect. When the coordinator is running a pattern, the external interface inputs shall not override the pattern sequence.

The coordinator shall provide two types of permissive periods. The permissive period shall control the time period during which the coordinator releases the coord phase(s), allowing the controller unit to begin servicing calls on the non-coord phases.

The first type of permissive operation shall consist of a standard vehicle permissive. The length of the period shall be determined by the phase time and the minimum time. Minimum time equals minimum green or maximum initial + vehicle yellow + red clear.

The second type of permissive operation shall consist of a separate pedestrian permissive concurrent with the vehicle permissive. The length of this period shall be determined by the phase time and walk + ped clear + phase yellow + red clear.

When the controller unit yields during any permissive period, the coordinator shall allow the controller unit to service all the subsequent phase(s) in normal order before returning to the coord phase(s) and it shall not yield on subsequent permissive periods in the same cycle.

The internal Time Base Control shall be a special program operating within the controller unit. A minimum of 100 different Time Base Control events shall be capable of being programmed over a 99-year time frame on a Time-of-Day, Day-of-Week, and Month Day-of-Year basis.

Time Base Control events shall be entered through the controller unit front panel or transferred from another like controller unit. Time Base Control settings and activity shall be monitored on the controller unit display.

The Time Base Control program shall output dial, split, and offset commands to the coordination program. It shall be possible to perform functions not necessarily traffic related within the Time Base Control program by programming and using the three auxiliary outputs.

The Time Base Control shall be provided with a line frequency driven clock and backed up by a battery supported crystal controlled clock. During normal operation, the line frequency driven clock shall control all timings and resynch the crystal controlled clock to the line frequency clock once per minute. When power is removed and reapplied, the crystal controlled clock shall provide the current time to the line frequency clock.

A battery backup voltage source shall be provided with the TBC circuitry. In the battery backup mode time shall be maintained to within $\pm 0.005\%$ as compared to WWV time standard.

The Time Base Control shall provide for daylight savings time to be programmed to occur automatically as defined by law in most states, to occur automatically at any user selected date, or not to occur.

A program day shall be the list of traffic and/or auxiliary events to occur in a 24 hour period. The Time Base Control program shall provide for at least 99 program days to be defined.

It shall be possible to equate program days which may require the same event listing to effectively multiply the event capacity.

It shall be possible to copy an entire program day event listing to another program day to establish a data base for editing to create a similar but different program day event listing.

The exceptions to the normal day-of-week event listings shall utilize Time-of-Year Special program days. Part of the Time-of-Year Special program days shall be utilized for special day programs which occur on the same date (month and month day) every year, and part shall be utilized for special days which occur on one date (year, month, and month day).

The Time Base events shall be implemented from a weekly schedule of program days on a day-of-week (except for special days) basis.

The Time-of-Year event structure shall provide a means of substituting two alternate weekly schedules for the normal weekly schedule.

In addition to dial, split, and offset commands, the Time Base Control program shall provide the following as traffic events:

- (a) Flashing (voltage monitor inactive)
- (b) Free
- (c) Maximum two timing by phase
- (d) Phase omit by phase

Maximum two Timing by Phase and Phase Omit by Phase are Free Mode modifiers and shall not be part of an event which selects a pattern (Dial/Split/Offset) or Flash.

There shall be three auxiliary outputs available. Each output shall be non- cyclic, each totally independent of any other output. The outputs shall not be affected by any other input including the On-Line input. The auxiliary outputs may begin and/or end concurrently with another program.

The coordination programs shall be capable of being selected based on manual (keyboard) inputs, Time Base Control event, and interconnect inputs. Program select priority shall be:

- (a) Manual Inputs
- (b) TBC Events
- (c) Interconnect Inputs

When the TBC On-Line input is active, the TBC events have no priority and program selection shall be based on manual inputs or interconnect inputs.

When the On-Line input is active, the coordination routine reverts to TBC control based on sync monitor failure.

642.02.5--Preemption. Internal Preemption shall be a special program operating within the controller unit. The preemption program shall accept commands from at least two preempt inputs and provide the timing and signal display programmed to occur in response to each.

The preemption program shall recognize the current signal display at the time of preempt and shall provide transition timing and signal display to the programmed preempt condition. Two preempt conditions with an intermediate set of clearances shall be capable of being programmed; i.e., Track Clear and Dwell. Once the preempt dwell has been satisfied, the preemption program shall provide an exit transition timing and signal display to the programmed return-to-normal condition.

Preemption parameters shall be entered through the controller unit keyboard or transferred from another like controller unit. Preemption settings and activity shall be capable of being monitored on the controller unit display. Preemption controls shall be internally applied and shall override the standard unit input modifiers.

The preemption program shall provide 13 timing intervals for each preempt routine and one timing interval for each ring in the controller unit. The timing Intervals and Range shall be:

<u>Interval</u>	<u>Range in Seconds</u>
I. Min Grn/Wlk - Ring 1	0 to 99
II. Min Grn/Wlk - Ring 2	0 to 99

The minimum timing intervals per preempt routine shall be as follows:

<u>Interval</u>	<u>Range in Seconds</u>
A. Delay Before Preempt	0 to 99
B. Preempt Duration	0 to 999
1. Selective Ped Clear	0 to 99
2. Selective Yellow Clear	0 to 9.9
3. Selective Red Clear	0 to 9.9
4. Track Green	0 to 99
5. Track Ped Clear	0 to 99
6. Track Yellow Clear	0 to 9.9
7. Track Red Clear	0 to 9.9
8. Dwell (Hold)	0 to 99
9. Return Ped Clear	0 to 99
10. Return Yellow Clear	0 to 9.9
11. Return Red Clear	0 to 9.9
** Exit Phase	Return-to-Normal Display

The preemption program shall provide the signal display for an orderly and safe transition from the point of entry to the first preempt green state (Track Green), from the first to second green state (Track Green to Dwell), and from the second green to the return-to-normal green state (Dwell to Normal).

The controller unit shall be provided with a resident series of diagnostic capabilities describing its own internal state. It shall not require internal access or changes to the controller unit to initiate diagnostic programs.

The controller unit shall perform diagnostics enabling operator verification of proper operation.

The "automatic" diagnostics shall be performed without an operator request. The diagnostics evaluation shall be displayed on the controller unit front panel display.

The controller unit shall contain provisions to monitor the operation of the microprocessor. The monitor shall receive signals at least once every 100 milliseconds from the microprocessor. When the signal is not received for 200

milliseconds $\pm 20\%$, the processor monitor shall initiate flashing operation, Voltage Monitor output inactive.

When flashing is initiated as a result of the processor monitor, it shall illuminate a front panel indication labeled "Watchdog". The monitor shall be deactivated when there is a power failure and shall become active when power is restored.

The monitor shall attempt an automatic restart of the microprocessor to the power up Start Flash timing condition. The controller unit shall operate as though power had been removed long enough for a full restart and reapplied. The front panel Watchdog indicator shall remain illuminated until the controller unit front panel has been manually addressed.

The controller unit shall perform diagnostics enabling operator verification of properly operating inputs, outputs, keyboard, and display. The "operator initiated" diagnostics shall be performed only after an operator request through the controller unit front panel.

For all input and output functions, standard and special, the controller shall simultaneously display the state of all functions of a given category so that conditions such as a missed wire or crosstalk errors may be instantaneously demonstrated.

642.02.6--Alarm Monitoring. The controller shall monitor and maintain internal logs of the following conditions, as a minimum, including the date and time of occurrence. These logs shall be displayable on the controller unit, printable via the RS232 port and transmitted to an on-street master or personal computer. As a minimum the following event change of status shall be logged:

Cycle Fault	Voltage Monitor	Preempt
Coord Fault	Conflict Flash	Local Free
Coord Failure	Local Flash	Special Status
Cycle Failure	Remote Flash	Power On/Off

A minimum of the last 40 events shall be maintained in the controller unit.

642.02.7--System Detectors. The controller shall have the ability to receive input data from up to eight special system detectors in addition to the normal actuated controller unit phase detectors. The user shall have the option to assign any of the phase detectors as "system detectors".

The controller shall process all system detector data, consisting of volume and occupancy, and shall be capable of transmitting the results of this processing to either the on-street master or computer, local or remote. As a minimum, the following parameters shall be determined per system detector:

- raw volume count
- raw occupancy percent
- average volume percent
- average occupancy percent

The controller shall generate a System Detector Report based on an operator determined logging interval and sample period. The report shall include raw volume and occupancy along with averaged volume and occupancy percent for the sample period. This report shall have the capacity to store up to six sample periods. A sample period data set shall remain until the report capacity is exceeded at which time the oldest sample period data set will be replaced by the new data set.

Each detector, both phase and special system, shall be tested by a diagnostics routine for conformance to specified parameters. The detector diagnostics shall monitor activity on each detector for constant calls, absence of calls, and erratic output. These parameters shall be user programmable.

Detectors which have failed the diagnostics and those subsequently operating within diagnostic parameters shall be automatically logged in a Detector Failure Report, including date and time of occurrence. This report shall have the capacity to store up to 20 diagnostic events and the event shall remain until the report capacity is exceeded at which time the oldest event will be deleted and the new event added.

The controller shall provide speed monitoring capability in the form of a Speed Trap function. The controller unit shall provide for up to two independent Speed Traps with operator selectable detector spacings of either 11 or 22 feet, dependent upon the application. Provision shall be made in the controller to monitor the speed in miles per hour. A nominal speed range shall be settable for each pattern, with the percent of vehicles higher, within and lower than this nominal speed range logged for reporting.

A Speed Report shall be provided and shall have the capacity to store up to 12 patterns of Speed data. The pattern Speed data shall remain until the report capacity is exceeded at which time the oldest pattern Speed data shall be deleted and the new added.

The controller shall provide a Communications Report, when used with an on-street master, which will allow the user to view a list of communication failures along with date and time of occurrence. This report shall have a minimum capacity of 20 events (faults). The fault event, including date and time of occurrence, shall remain until the report capacity is exceeded at which time the oldest fault shall be deleted and the new fault event added. This report shall be displayed, printed and transmitted in the same manner as the Alarm Log.

Indication shall be provided on the front panel of the controller unit to denote when a carrier signal is being received, valid data is being received and when the

unit is transmitting.

642.02.8--Documentation. Documentation packages shall be delivered for each unit at the same time as the equipment to which it pertains.

The documentation packages shall contain a parts identification that shows the location of every individual component. This includes integrated circuits, transistors, resistors, capacitors, inductors as well as test points, switches and indicators. Parts identification may be imprinted, stamped or etched on circuit boards in lieu of the pictorial layout, provided such markings are in no way obscured from normal viewing as a result of parts mounting and shall be referenced to the schematic.

The documentation packages shall contain a parts replacement guide so that any component needing replacement can be identified. It shall be possible to use the parts replacement guide for information to either find an industry standard replacement part or order a needed component from the manufacturer.

The documentation packages shall include a schematic of each component and printed circuit board to include identification of all parts and terminals.

Data on all ICs shall consist of at least a schematic symbol, a truth table, and identification of pin setting and their functions.

The documentation packages shall include complete electrical and mechanical installation procedure for each type of unit. Procedures shall be precise and easy to understand.

Maintenance and trouble-shooting procedures shall be included and referenced to the schematics so that block checks can be made to locate any defective components. Point to point voltages shall be included that are pertinent to proper servicing. Test points must be easy to locate and contact with test instrument probes.

A complete physical description of the units shall be provided to include at least the physical dimensions of the unit, weight, temperature ratings, voltage requirements, power requirements, material of construction, and complete performance specifications.

A complete set of operation guides and user manuals shall be provided. These documents shall fully cover all programming procedures and programmable options capable of being made to the controllers and associated traffic control equipment. Instructions for modifications within the range of the capabilities of the unit such as changes in phases or sequences and programming matrix boards shall be included.

For each type of controller unit to be supplied, a list of each type of module, subunit, or complete unit contained within the unit or cabinet shall be provided.

If the manufacturer of the equipment enhances the software or other operation systems of the controller unit, coordination program or time base program between the time the project is let and the time it is accepted, the manufacturer shall update the units that have been changed at no additional cost. The units that are in place at final acceptance shall have all of the refinements that have been made up to the date of acceptance.

642.02.9--Cabinets for Control Equipment. These cabinets shall be of minimum dimensions and at locations as indicated on the plans.

Basic Construction - The controller and all associated equipment shall be provided in a weatherproof metal cabinet of clean-cut design and appearance. All exposed edges shall be free of burns and pit marks.

The cabinets shall be welded steel or aluminum construction meeting the requirements of Subsection 722.13. The cabinet shall have a smooth natural finish. Handles and locks shall be rust proof.

Welds - All welds shall be neatly formed and free of cracks, blow holes, and other irregularities. All welds shall be made by the Heliarc welding method. Welds on the exterior faces of the cabinet shall be reduced to a minimum.

All cabinets shall be provided with a hinged, rain tight and dust tight main door which shall encompass at least 80 percent of the full area of the cabinet front. The main cabinet door shall have a number two Corbin lock. Two keys shall be supplied with each cabinet and shall be securely attached to the outside of the cabinet when delivered. A neoprene gasket shall be used to seal the main cabinet door. Hinges shall be made of 14-gauge stainless steel. All cabinets shall be furnished with at least two position door stops which shall hold the main door open at approximately 90 and 180 degrees. The door stops shall be designed to lock into position and withstand the force of a 30-mph wind. A three-point locking system shall be required and shall consist of the following security points:

- (a) Center of cabinet by lock,
- (b) Top of cabinet operated by door handle, and
- (c) Bottom of cabinet operated by door handle.

Security points (b) and (c) shall be designed so that they will remain in the locked position until the main cabinet lock is unlocked. Door handle operation shall be such that the handle is vertical when in the locking position, and the opening motion shall swing the handle away from the location where the key is inserted. The handle shall be capable of being padlocked to prevent opening

when padlocked.

A small hinged, and gasketed "door-in-door" or "police door" shall be included on the outside of the main controller door. The auxiliary door shall not allow access to the controller, its associated equipment, or exposed electrical terminals, but shall allow access to a small "Police" panel. The police door shall encompass the full area of the police panel. The police door shall be equipped with a lock whose key will not unlock the main door. Two keys shall be furnished for each lock and shall be securely attached to the outside of the cabinet when delivered. The police door shall be located in the top half of the main door. The police panel may be either of cast aluminum or sheet aluminum. The police panel shall contain the following:

- (1) Signal-head power switch. When in the OFF position all power to the signal heads shall be removed.
- (2) Flash switch. When in the ON position, the intersection shall flash as shown on the plans. AC power shall be removed from the load switches. Stop timing shall be applied to the controller.

Each cabinet shall contain at least two adjustable shelves to accommodate mounting of the controller and all included auxiliary equipment. The shelves shall permit the controller and/or auxiliary equipment to be withdrawn from the cabinet for inspection or maintenance without breaking any electrical connections or interrupting operation of the controller. The range of adjustability shall be the full height of the cabinet in maximum increments of two inches. Screws used for mounting shelves or adjustable shelf mounts shall not protrude beyond the outside wall of the cabinet.

The manufacturer's name shall not appear on the outside of the cabinet, but shall appear on the inside of the cabinet door, with the year and month of manufacture. This can be done by a plate welded to the door, or by a moisture resistant label or other approved methods.

In all cases, the cabinet shall be of adequate dimensions to properly house the controller, a coordinating unit if required, and all required appurtenances and auxiliary equipment intended to be contained therein; all in an upright position, with a clearance of at least three inches from the vent fan and filter, to allow for proper air flow. In no case shall more than 70 percent of the cabinet space be used. There shall be at least two inches of clearance on each side of the shelf between the equipment and side walls of the cabinet.

Unless the plans specify pole mounting, the cabinets shall be arranged and equipped for base mounting on a concrete foundation. An anchor bolt template, galvanized anchor bolts, nuts, and hardware as required for base mounting shall be furnished with each cabinet. The Contractor shall caulk around the base of the cabinet and foundation to seal the cabinet and prevent moisture and dirt from

entering the cabinet.

The cabinet shall contain suitably designed, rain-tight vents on the door of the cabinet. Vents shall allow the release of excessive heat and/or any explosive gases which might enter the cabinet. Vents shall have adequate opening area to permit the proper flow of air drawn by the vent fan. The intake vent shall be designed so that no water will be drawn into the cabinet.

The intake and exhaust vents shall be located such as to provide for maximum passage of air around and over the equipment contained therein. A removable dust filter shall be mounted on the inside of the main door completely covering the intake vent. The cabinet air filter shall be of the throw-away type and its minimum area shall be 250 square inches. The filter shall be installed, positioned and firmly held in place so that all intake air is filtered with no by-passing permitted through cracks, clearance spaces or gaps. Positive retainment shall be provided on all sides to prevent warpage of the filter and prevent the entry of foreign matter around the edges. All cabinets shall have a thermostat controlled exhaust fan located at the top of the cabinet. The exhaust fan shall have a minimum rating of 100 CFM. The fan shall be rated for continuous duty and a lifetime of at least three years. A standard fuse of sufficient rating shall be used to protect against surges and short circuits. The thermostat controlling the exhaust fan shall be manually adjustable to turn on between 90°F and 150°F with a differential of not more than 10°F between automatic turn-on and turn-off.

Service switches shall be required for all cabinets. The following toggle switches shall be provided in the cabinet.

- (1) Run-remote-stop time switch. A three-position run-remote-stop time switch can be used to put the controller in stop time manually or by remote input.
- (2) Flash switch. When in the ON position, the intersection shall flash as stipulated on the plans. AC power shall be removed from only the load switches.
- (3) Controller ON-OFF Switch. When in the OFF position, AC power shall be removed from all circuits of the controller assembly and the intersection shall go to flashing operation.
- (4) Detector test pushbutton switch. A detector test pushbutton switch for each vehicle and pedestrian detector circuit shall be provided in a panel on the inside of the front door. The switch and wiring shall place an actuation for the respective vehicle or pedestrian phase when pushed. The switch(es) shall be labeled "Call Switch" and the phase # as well as whether it is vehicle or pedestrian.

A three wire 115-V AC duplex ground fault interrupt (GFI) receptacle shall be mounted and wired in the cabinet. The receptacle shall have a 15-ampere circuit breaker and shall remain in service even when the power switch is turned off. All cabinets shall be provided with a minimum of a 20-watt fluorescent fixture with bulb mounted in the top of the cabinet. A toggle switch shall be provided to turn the light on and off.

The wiring in the cabinets shall conform to applicable requirements of the National Electrical Code (NEC), NEMA and all of the specifications contained herein. All wiring shall be neat and firm. Wires shall be neatly laced into cables with nylon lacing or nylon tie wraps. Cables shall be secured with nylon cable clamps. The controller equipment and terminals shall be so arranged within the cabinet that they will not conflict with the entrance, training, and connection of the incoming conductors, and will be easily traceable and without entanglement. All terminal strips and load switches for field wiring shall be exposed for test purposes or maintenance without removal of the controller or its related equipment. MS connectors and wiring harness for the controller unit, conflict monitor and external logic units shall be furnished and wired into the cabinet. All conductors which are subject to flexing during the opening of cabinet doors, or the removal of equipment shall be stranded with a minimum of 19 strands. All conductors used in the controller cabinet shall be AWG #22 or larger, and shall conform at least to Military Specification: MIL-W-16878D, Type B or D, Vinyl - Nylon jacket, 600 volt, 105°C. Conductors used in controller cabinets shall conform to the following color codes: AC- neutral = white; AC+ line = black; Safety Ground = white w/green stripe. Safety ground is to be electrically isolated from AC- neutral. All wires shall be proper length before assembly. No wire shall be doubled back to take up excessive length. The wire and insulation shall be adequate to handle the current and voltage used in the cabinet. The harnesses shall be neatly arranged and provided with the flexibility for the connectors to reach at least 40 inches from the top of the terminal block panel.

Cabinets for four-phase controllers shall be wired and shall have the necessary logic to provide two vehicle overlaps with capability of being assigned some combination of phases at a future date by the simple addition of wire jumpers.

Electrical connections from the controller and auxiliary devices to outgoing and incoming circuits shall be made in such a manner that the controller and/or auxiliary devices can be replaced with a similar unit, without the necessity of disconnecting and reconnecting the individual wires leading therefrom. This shall be accomplished by means of MS connectors and other approved NEMA standard connectors using the NEMA standard pin assignments.

Terminals shall be provided, as a minimum, for the following:

- (a) Terminal with circuit breaker with an internal power line switch for the incoming power line;

- (b) Terminal, unfused, for the neutral side of the incoming power line;
- (c) Terminals and bases for signal load switches and outgoing signal field circuits;
- (d) Terminals and bases for signal flasher and outgoing signal field circuits;
- (e) Terminals for detector cables;
- (f) Terminals for all required auxiliary equipment;
- (g) Terminals for interconnect cable and coordination equipment;
- (h) Terminals for future preemption input lines; and
- (i) Terminals for installation of incoming and outgoing multipair voice grade telephone lines.

Adequate electrical clearance shall be provided between terminal strips. The controller and auxiliary equipment, panel(s), terminals and other accessories shall be so arranged within the cabinet that they will facilitate the entrance and connection of incoming conductors.

Soldering of conductors to terminal lugs may be omitted provided a calibrated ratchet-type crimping tool is used.

All input and output circuit connections to the controller unit, conflict monitor, external logic units, load switches, loop detectors, coordination units, and all other auxiliary equipment shall be made by the use of terminal strips.

Terminal strips shall be provided for connecting the field wires to the output of the load switches. Four terminal strips shall be included in cabinets to permit connecting a minimum of 48 field wires and four terminal strips for connecting a minimum of 48 loop detector wires, which shall include wiring for AC+ and AC-. Terminal strips shall be provided for connecting the controller outputs to the load switches. All terminal strips shall have their connections numbered. A wiring chart shall be provided on the inside of the main cabinet door, to identify the connections of the terminal strips. It shall be completely legible.

The outgoing signal circuits shall be of the same polarity as the line side of the power service; the common return of the same polarity as the grounded side of the power service.

A copper ground buss bar shall be mounted on the back or side of the cabinet wall for the connection of A.C. neutral wires and chassis ground wires. It shall be securely fastened to the cabinet. If more than one ground buss bar is used in a cabinet, a minimum of a No. 10 AWG copper wire shall be used to interconnect them. Each buss bar shall have at least two positions where a No. 6 AWG stranded copper wire can be attached.

All cabinets shall be furnished with a minimum of two circuit breakers having a rating of at least 30 amperes. One circuit breaker shall control the duplex outlet and the service lamp. The other circuit breaker shall control all other electrical

connections.

Each cabinet shall be provided with surge protection as follows:

- (1) AC service input shall be protected by a unit capable of withstanding at least 20 surges of at least 20,000 amperes each. The unit shall have at least three active clamping stages and have internal follow-current limiters. The unit must self-extinguish within 8.5 milliseconds after the trailing edge of the surge. The parallel impedance of the limiters shall be less than 0.15 ohms. The peak clamp voltage shall be 350 volts at 20 kA.
- (2) Each detector input line from a remote detector cabinet or pedestrian push-button shall be protected by a two stage hybrid device capable of withstanding a minimum of 30 surges of at least 5,000 amperes each applied to the input. The device shall have one input lead, one output lead, and a ground lug in order for the signal wire to "pass through" the protector. The voltage across the output must be held to 30 volts when the input is subject to a 2,000-ampere, 10 x 20-microsecond surge. The unit must not interfere with the normal operation of the signal equipment, and must respond in less than 20 nanoseconds.
- (3) The interconnect lines and signal loads shall be protected by a unit capable of withstanding a 10-kA, 8 x 20 nanosecond surge five times without damage. The response time of the unit shall be less than 50 nanoseconds. The maximum clamping voltage shall be no greater than 400 volts at 1 MA. The units must be individually packaged for interconnect line protection and in a package of three for the signal loads.
- (4) The external data communications pair shall be protected at the cabinet entry point by a two stage series hybrid device capable of withstanding a peak surge of 4000 amps, 8 x 20 micro-second wave form. The device shall have a minimum life of 50 surges @ 4000 amps with a response time of less than 20 nano-seconds. The maximum clamping voltages shall be 200V on the incoming telephone line and 15V on the incoming multi-pair voice grade interconnect line.

A radio interference suppressor shall be provided in a series with A.C. power before it is distributed to any equipment inside the cabinet. The filter shall provide a minimum attenuation of 40 decibels, and a frequency range of 200 kilohertz to 60 megahertz. It shall be hermetically sealed in a metal case. The filter shall have the same minimum circuit rating as the main circuit breaker and shall meet the standards of the Underwriter's Laboratories, Incorporated and Electronic Industries Association.

The manufacturer shall provide cabinet noise suppression as required by the particular controller. The thermostat contact and vent fan shall be properly

suppressed.

Each cabinet shall be furnished with three copies of the cabinet wiring diagram and field wiring diagram. These prints shall be full size and completely legible. Where possible, diagrams shall be to a scale picture image of the cabinet layout. Diagrams shall shown the complete wiring of all cabinet components, all switches, terminal board connections, connector connections, fan connections, light fixture connections, flash transfer relays, lightening arrestors, surge protectors, load switch panels, terminals, and any other control functions. Each item shall be clearly identified as to its function.

All components in the cabinet shall be located according to their function and in such manner that they may easily be found on the wiring diagram.

Field wiring and cabinet wiring diagrams shall be designated on the diagrams using the traffic movement designations as shown on the plans. Association of phase numbers with their designated traffic movement shall be clearly indicated on the wiring diagram.

A clear plastic pouch approximately 10 inches x 14 inches with a sliding-lock shall be provided for each controller. The pouch shall not be mounted inside the controller cabinet, but shall be loose for placement inside the controller cabinet.

Foundations. Foundations for traffic actuated controllers shall be constructed of Class "B" concrete meeting the requirements of Section 804, and in accordance with the details shown on the plans.

Anchor bolts for base mounted cabinets shall be 3/4-inch diameter by 16 inches long with a 90 degree bend with a 2-inch leg, overall length of 18 inches. The end opposite the leg shall be threaded for at least three (3) inches with a 3/4 UNC-10 thread. Anchor bolts shall be steel with a hot dipped galvanized or zinc plate surface. Four anchor bolts shall be required for each cabinet.

Traffic Actuated Controller Types. Traffic Actuated Controllers of the following types as shown on the plans and required in these specifications shall be furnished:

Type 4A - 4 phase	Type 8A - 8 phase
Type 4M - 4 phase	Type 8M - 8 phase

The 'M' Type controllers will be installed in an existing master system. It shall have full upload and download compatibility with the existing master and/or system.

An intersection plan and phasing diagram, including loop designations and detector chart, as noted in the plans, shall be affixed to the door and shall be

completely legible and waterproof.

642.03--Construction Requirements.

642.03.1--Construction Details. The installation shall be carried out in conformance with the requirements herein stated and shown on the plans, and shall present a neat and workmanlike appearance.

The required cycle lengths, offsets, splits, band widths, and time of day and week each is to occur for each coordinated system will be determined at a later and mutually acceptable (Contractor and Engineer) date after the contract is awarded.

642.03.2--Tests. After completion of installation of traffic actuated controllers the Contractor shall demonstrate by tests to the Engineer's satisfaction that (a) all circuits are continuous and free from short circuits, (b) that all circuits are free from unspecified grounds, (c) that the resistance to ground of non-grounded conductors is at least one megohm at 60°F measured with a 1000 ohms per volt megger, and (d) that the ground resistances are not more than 25 ohms.

642.04--Method of Measurement. Solid state traffic actuated controller units will be measured as unit quantities per each, such measurement being inclusive of foundation, mounting, cabinet, relays, terminals, circuit breakers, modules, coordination and time base control programs, connectors wiring, overlap equipment and wiring, load switches, controller mechanism and housing and being inclusive of all materials, work, testing and incidentals necessary for a complete and operable unit in place and accepted.

642.05--Basis of Payment. Solid state traffic actuated controllers, measured as prescribed above, will be paid for at the contract unit price per each for each type(s) specified in the contract; which price shall be full compensation for foundation construction, for furnishing cabinets, relays, terminals, circuit breakers, modules, coordination and time connectors, overlap equipment, load switches, controller mechanism and housing, mounting material, and all other materials; for constructing, installing, connecting, testing and final cleanup; and for all equipment, labor, tools, and incidentals necessary to complete the work.

Payment will be made under:

642-A: Solid State Traffic Actuated Controllers, Type - per each

SECTION 643 - CLOSED LOOP ON STREET MASTER SYSTEM

643.01--Description. This specification describes a distributive processing, traffic responsive, control and monitoring "closed loop" system. The system's principal operational task shall be to select and implement traffic signal timing

plans in response to both actual traffic conditions or time based events. To "close" the operational loop, the system shall monitor, in real time, local intersection activity and overall system performance, reporting failures and status conditions both automatically and by operator request. In order to meet current and future traffic control needs, the system shall also provide extensive control monitoring, data collection, reporting and analysis functions.

For complete user flexibility, the system shall provide full access of each local system intersection controller from the remote central-office site. Full access shall include the capability to upload all time settings, operation parameters and status information, as well as the capability to download all time settings and operation parameters. The system shall be designed to capitalize on the cost effective attributes of staged implementation. A building-block design shall be provided which enables future system expansion to occur without major modification to the existing system.

643.02--Materials.

643.02.1--System Configuration. The system architecture shall be designed to minimize the effect of equipment failures on system operation and performance. The system consists of four principal elements:

- Local System Intersection Controllers,
- Communication (Telemetry) Links,
- On-Street Master(s),
- Central-Office Computer Software

643.02.1.1--Local System Intersection Controller. The local system intersection controller shall be capable of controlling a fully actuated two to eight phase intersection and shall meet or exceed NEMA TS 1-1989 standards for fully actuated traffic control units. The local controller shall have internal communication capability with direct access to the data memory. The local system controller shall be capable of processing controller and detector data and provide all necessary intersection control functions.

The local system intersection control shall meet the requirements of Section 642, Solid State Traffic Actuated Controllers.

643.02.1.2--Communications (Telemetry) Links. The communications links for the "closed loop" system shall perform the following functions:

- (a) provide the medium for two-way communications between the on-street master and the local intersection controllers, and
- (b) provide the medium for two-way communication between the on-street master and the central-office computer facility.

Error checking shall be included in both mediums to assure transmission and reception of valid data.

Communications between the on-street master and the local intersection controllers shall require full period connection consisting of either: leased twisted pair designed for full or half duplex operation meeting the requirements of Bell 3002 unconditioned lines, or user owned dedicated hardwire interconnect of copper wire shielded, twisted pair cable. Communications between the on-street master and the central-office computer facility shall be provided by standard touch tone or pulse dial, two-wire dial-up telephone service capable of supporting 1200, 2400, 4800, 9600 and 19,200 baud data transmission. The system shall also provide auto-dial/auto-answer operation with this communications link in order to handle communications originating from either location without operator intervention.

643.02.1.3--On-Street Master. The on-street master may be located at an intersection and connected via the communication network to at least 24 local intersection controllers. The master shall be capable of implementing traffic responsive control, time base control, manual control or remote control modes of operation.

Analysis of sampling sensor data from at least 32 system detectors and corresponding selection of the best traffic responsive timing pattern shall be provided by the on-street master during the traffic responsive mode of operation.

Automatic and continuous monitoring of system activity shall be provided by the on-street master to include both master and intersection alarm conditions.

System parameter entry shall be provided via the on-street master including all master and local intersection assignment and group parameters. Master parameters shall include:

- (1) system coordination setup and pattern data entry by group,
- (2) system time base event scheduler,
- (3) system traffic responsive computational and pattern selection setup by group, and
- (4) intersection system group and detector assignments.

The on-street master shall provide comprehensive system report generation including, as a minimum: system, intersection, detector and failure status and history reports in addition to system performance reporting.

An RS-232C interface shall be provided on the on-street master to allow for printing of reports or for interconnecting to a remote central site.

To enhance overall system operation and increase system management

flexibility, the on-street master shall also support two-way dial-up communications to a central-office computer for control, monitoring, data collection and for timing pattern updating purposes, all from a remote central-office location. Continuous, 7 days/week - 24 hours/day, system monitoring shall be enhanced by the on-street master's capability to automatically dial-up the central-office computer upon detection of user defined critical alarm conditions.

643.02.1.4--Central-Office Computer Facility. The central-office computer software shall operate with the Departments current operating system or approved equal, and will permit output of status and failure reports, sensor reports and adjustment of parameters for up to 16 on-street master systems from a single site. The central-office computer facility is located in the user's office and shall be connected to the remote on-street master(s) and/or local intersection system controllers via two-way dial-up communications to enable outputs, monitor system operation, and upload/download master and local operational and timing parameters.

For ease of use, distinctive and simplified system parameter and status displays, the software shall provide menu-driven operator interface on a color monitor.

643.02.1.5--Central-Office Computer Hardware. The central office hardware shall consist of a microcomputer with a hard disk of at least 80 gigabytes of storage, a 3½" disk drive, two serial ports, one parallel port, a modem, and a CD-R drive for backup. One quad-pack of CD-R disks for backup shall also be included with the system. The central processing unit shall be a 2.8 gigabyte processor with at least one-gigabytes of RAM, or a system of approved equal. The CPU shall support the Departments operating systems.

The hardware shall also include a color monitor and color printer. The monitor shall have a minimum pixel rate of 1024 x 768 and a minimum screen size of 17 inches. The color printer shall have at least 2400 x 1200 color resolution and be capable of printing at least eight (8) color pages per minute.

Internal or external fax/modems capable of auto dial/auto answer operation, compatible with the on-street master and the user's central office computer system shall be provided in the controller cabinet and with the central office hardware. Communications shall be provided by either standard touch tone or pulse dial, over a two-wire dial-up telephone service, supporting 1200, 2400, 4800, 9600 and 19,200 baud rate transmission.

Certification shall be provided by the supplier/manufacture that the modems have met and passed NEMA TS 1-1989 environmental standards for actuated controllers or can verify that units in the field have been operational for over a two year period with no problems attributable to environmental conditions.

643.02.2--System Functional Requirements.

643.02.2.1--Operator Interface. In order to provide ease in programming and operation, the system shall provide a simplified user-friendly menu format at each local, master and central-office facility. No special programming skills shall be required for the user to fully access and operate this control and monitoring system at any level.

All programming, both of the local intersection controllers and the on-street master(s) shall be via a front panel keyboard and display, driven by English Language menus. All data change entries will be automatically verified against established ranges prior to acceptance to prevent programming data errors. Data access shall be controlled by user definable access controls.

643.02.2.2--System Traffic Control. The system shall have the capability of implementing a minimum of four dials, four splits and three offsets for a total of 48 unique timing patterns for each group.

The system shall provide the capability of selecting any of the following operational modes on a group basis:

- (1) Traffic Responsive,
- (2) Time Base (Time-of-Day/Day-of-Week),
- (3) Remote (External Command) and
- (4) Manual (Operator Entry).

The system shall be capable of implementing system Flash and system Free operation. The system shall have the capability to command, on/off based on time, up to eight independent special functions.

643.02.2.3--Detectors. The system shall have the capability of accepting and processing data from at least 32 system detectors for traffic responsive program selection.

643.02.2.4--Pattern Selection. In addition to providing Manual and Remote program selection capability, the master shall provide for Traffic Responsive and Time Base modes of operation for timing pattern selection.

643.02.2.4.1--Traffic Responsive Mode. Traffic plan selection in the traffic responsive mode shall be user enabled. The pattern selection shall be based on sampling detector volume and occupancy analysis by the on-street master. Smoothed volume and occupancy sensor data will be processed at the local system intersection controller, based on a user settable averaging time per system detector, and passed to the on-street master. Any of up to eight detectors at the intersection shall be assignable to each of the functional computation channels in each group, with the channels representing: cycle-selection, directionality (offset), non-arterial flow (split), and special congestion indicators of queue and occupancy.

The operator shall have the option of using either averaged data or highest sensor for each computation function (channel). Additional control shall be provided in the traffic responsive operation mode by allowing the operator to establish the number of failed detectors required to fail the channel. A user selectable weighting factor shall be assignable to each system detector input associated with each channel.

All threshold transition points used to define traffic plan levels will be operator specified and shall be provided with decision points such that one and only one traffic pattern will be selected by the volume and/or occupancy level. In addition there shall be a user-selectable minimum time between plan changes.

643.02.2.4.2--Time Base Mode. The system shall provide the capability of implementing time-of-day, day-of-week and week-of-year control for each of the two groups using an internal timeclock referenced to the 60-Hz AC power line frequency for its time base. The Time Base Mode shall contain automatic adjustment for leap year and daylight savings time changes.

The system Time Base Mode shall provide, as a minimum, 100 events each capable of requesting:

- (1) any of the 48 traffic control patterns along with traffic responsive override enable, or
- (2) auxiliary events consisting of enable/disable any of up to four system-wide special functions and setting sample and log interval time periods.

The Time Base Mode of operation shall provide a traffic responsive override which when enabled, the traffic responsive program will override the Time Base program whenever its cycle length is greater than that being commanded by the Time Base. It shall be possible to call for Traffic Responsive control of plan selection from the Time Base Mode.

The system Time Base Mode shall also provide the capability to program special events on a one-time basis for implementing holiday plans or special events up to one year in advance. The capacity for at least 99 special or exception days, as well as a minimum of three alternate week programs shall be available for programming.

All Time Base control commands shall be programmable to a one-minute resolution and shall be configured from events made into day programs which form part of a week program.

The timeclock shall have the capability of maintaining accurate time in the event of a loss of AC power to the clock.

643.02.2.5--System Control Priority. The system coordination control

(program-in-effect) for each group shall be selected on a priority basis. The priority from highest to lowest shall be as follows:

- (1) Manual Control Entry
- (2) External Control (Remote Command)
- (3) Time Base Control (Time-of-Day/Day-of-Week)*
- (4) Traffic Responsive Control.

* Traffic Responsive control will prevail whenever Traffic Responsive Override Enable is active and the selected cycle length is greater than that being commanded by Time Base.

643.02.2.6--Measures of Effectiveness. The system shall have the capability to report selected Measures of Effectiveness (MOE's) on an intersection basis. MOE calculations shall be made on all phases by the local system intersection controller and as a minimum shall include measures such as: Volume, Number of Stops, Delays and Green Utilization. These measures shall be calculated on the basis of the active timing plan. Alternate ways of reporting MOE'S may be approved on a case-by-case review.

643.02.2.7--Uploading and Downloading. The system shall provide, for any selected local system intersection controller, the capability of uploading and downloading any or all, new or modified local intersection parameters from the central-office computer and shall include as a minimum all: Phase Timing and Unit Data; Coordination Data; Time Base Data; Preemption Data; System Communication Parameters; System Traffic Responsive Data; and any other System Data residing at the intersection such as Detector Diagnostic Values, Report Parameters and Speed Parameters.

During either uploading or downloading operations normal traffic control operations shall not be suspended. All data shall be continually accessible and may be displayed at the on-street master or the central-office computer.

643.02.2.8--System Monitoring and Diagnostics.

643.02.2.8.1--Monitoring. The system shall automatically and continually monitor system activity and log/report occurrences of master and intersection alarm conditions. All alarm condition events shall include at the intersection, master and central-office computer, an alpha-numeric description of the event, and the time and date of occurrence.

As a minimum, monitored master alarms conditions shall include:

- (a) insufficient or improper data,
- (b) failed computational channels,
- (c) failed system detectors,

- (d) intersection communication failure,
- (e) failed controllers, and
- (f) at least six special user defined alarms for user application flexibility.

Monitored intersection alarms conditions shall include, as a minimum:

- (a) cycle faults and failures,
- (b) coordination failures,
- (c) voltage monitor,
- (d) conflict, local and remote flash conditions,
- (e) preempt,
- (f) local free, and
- (g) at least six special user defined alarms for additional user flexibility.

When the master detects a critical alarm condition, as defined by the user, it shall automatically dial-up the central-office computer and report the condition. On a busy or no answer the system may be programmed, at user option, to alert a secondary computer.

The system shall also automatically and continually monitor, verify and attempt to correct Sync Pulse, Time Base Clock and Pattern-in-effect.

643.02.2.8.2--Diagnostics. The system shall provide capabilities to perform diagnostics on system and local detectors, communications and intersection operations. When a fault has been detected an indication shall be provided. It shall be possible to isolate the fault to the failed unit from controls and indicators available on the master unit. Auxiliary equipment such as a data terminal or CRT shall not be required to identify the failure.

- (a) Sensor Monitoring. Each system and local detector shall be continually verified for proper operation. The local system intersection controller shall maintain a log of all detector failures including date and time of failure and resumption of proper operation. As a minimum, each detector shall be continuously monitored for constant calls, absence of calls, and erratic output.

To prevent program selection based on erroneous detector data, system sensors which fail the monitoring test shall be automatically deleted from volume and occupancy calculations. Upon resumption of satisfactory sensor operation, sensors shall automatically resume input to volume and occupancy calculations. The operator shall be capable of designating the required number of failed system detectors, assigned to a traffic responsive channel, before the channel is classified as failed.

- (b) Communications Monitoring. The master shall provide the capability to diagnose and log failed communications that exhibits no response or

generates invalid feedback. The diagnostics shall enable the user to identify the particular failure and shall provide visual indication of the failure on the master front panel.

- (c) Intersection Diagnostics. Intersection status conditions shall be available for diagnostic display. These diagnostics shall include:

Intersection Status - As a minimum, the master and intersection shall provide for diagnostic display of cycle failure, local free, local flash, conflict monitor flash and voltage monitor flash.

Controller Phase Status - The master shall provide for the real-time display of the controller phase Greens, Yellows and Reds, along with pedestrian WALK and flashing DONT WALK.

Controller Detector Inputs - Provisions shall be made for the real-time display of the intersection detector inputs to the controller on a per-phase basis.

Intersection System Status - The local controller shall provide for real-time diagnostic display of the intersection system operation and identify cycle failure and failure of intersection to display coordinated phase green time at the proper offset.

Controller Inputs/Outputs - In addition to other monitored signals described above, a minimum of six undefined special input functions and eight undefined special output functions shall be provided to be used as desired by the user.

643.02.2.9--Real Time Display. The master shall provide for any selected local system intersection controller, real-time status information on it's front panel. Real-time intersection status information shall include simultaneous display of: vehicle and pedestrian signal and detector status by phase, overlap signal status and cars waiting count by phase. Real-time controller status information shall include simultaneous display of: two Ring Active timers; On/Next, Call/Recall and Hold/Omit Status by phase; Coordination, Preempt and Stop Time Status.

643.02.2.10--System Management. The system, without hardware changes but with its ability to directly modify master and intersection parameters, shall provide the user system configuration and system operational controls of the following functions: add/delete controllers and system detectors; enable traffic responsive mode; assign intersections to groups; assign system detectors to computational channels and channels to pattern select routines; and assign special and/or standard detectors as system detectors for use with computational channels or to track activity.

643.02.2.11--System Logging and Reports. The system shall automatically and continually process system data and log/report on occurrence of changes in the following:

Intersection Status, System Detector Status, Communications Status, Controller Status and Local Detector Status; in addition to System Program Changes, Traffic Responsive Computations, Measures of Effectiveness and Performance.

The reports shall be output via a printer or uploaded to the central-office. The reports shall be obtainable on demand, at the master or central-office, or output automatically at the central-office computer facility at regular intervals as specified by the user.

643.02.2.12--Security. The on-street master shall provide for a user specified security code entry before any data may be altered. In order to view any parameter, security code entry shall not be required. Security access shall be automatically rescinded approximately ten minutes after either access was gained or the last parameter change was entered. The master and local controller shall have the ability via keyboard to disable security code requirements, allowing for perpetual access without requiring hardware changes.

Master and local controller access procedures shall be maintained from the central-office computer facility allowing the user full security control of all system components from a remote location.

643.02.3--Design Characteristics. The On-Street Master shall be designed to operate in either an office or field environment and shall be suitably housed in a separate enclosure or in a local intersection cabinet. The master shall be designed to meet the following electrical and mechanical requirements:

643.02.3.1--Programming and Security. Operator programmable data entry shall be accomplished through panel keyboard(s). The master shall prevent the alteration of keyboard set variables prior to the user having entered a specific access code through the keyboard. The master shall maintain user programmable variables in non-volatile memory a battery-backed RAM to assure continued efficient system operation.

To insure the accuracy of the traffic control parameters, EEPROM technology or battery-backed RAM shall be used to retain all timing and control parameters, even during power outages. Non-critical historical data retention and the Time Base clock shall utilize RAM memory and in the event of power failure, those functions shall be maintained by battery support for a minimum of one year.

643.02.3.2--Electrical and Environmental. The on-street master unit shall conform to all applicable portions of the Environmental and Operating Standards

as described in NEMA Standards Publication No. TS 1-1989, Section 2.

643.02.3.3--Construction. The on-street master unit shall conform to all applicable portions of the physical requirements as described in the NEMA Standards Publication No. TS 1-1989, Section 14. In addition the master unit shall be designed consistent with maximum commonality between the local intersection controller hardware and shall utilize the absolute minimum number of printed circuit boards, wiring harnesses, ribbon cables and connectors.

643.02.3.4--Test and Repair. To enhance maintenance and trouble-shooting activities, on-street masters shall include resident diagnostics as a standard. No extender-cards, special tools or PROMs shall be necessary to fully maintain these components. The master unit design shall insure that all printed circuit boards be readily accessible for maintenance testing purposes. All fuses, connectors and controls shall be accessible from the front of the master unit.

643.02.4--Central-Office Computer Software. The central-office computer software shall have the capability to integrate at least 512 intersections into a centrally-monitored system, and shall be able to communicate with at least 16 separate on-street masters through either dial-up telephone service or direct line.

643.02.4.1--System Monitoring. All masters, groups within masters, and individual intersections shall be identified and accessed by name to assist the operator in relating actual geographic locations. The name shall be user definable and consist of up to 24 standard ASCII characters. This name shall appear on all displays and reports.

The central-office computer software shall have the capability of monitoring the operation of the master and the performance of any local intersection in the system.

The central-office computer software shall receive system and intersection data from the on-street master(s) and shall tabulate, format and output reports at the central-office site. Alarm conditions, as described in Subsection 643.02.2.8 shall be reported to the central-office computer.

Master status monitoring information shall be available on demand to the central-office computer and shall include, as a minimum:

- (1) group active status which shall report the active operating mode, cycle length, pattern, cycle counter and special functions of each group,
- (2) intersection and detector master status which shall report on the current status of every intersection and system detector, and
- (3) time base master status which shall report on the current status of the Time Base mode of operation.

Local intersection monitoring information shall be available with the central-office computer software and shall include as a minimum, local status conditions of: coordination, preemption, time base and detector functions as well as controller unit status indicating real-time status of all phases and ring timers. Data shall be updated once a second or upon change and shall remain on the display until cancelled by the operator.

643.02.4.2--Remote Real-Time Display.

On-Street Masters. The central-office computer software shall provide real-time information for any selected on-street master group. These color displays shall include the following status information as requested by the user: Program-in-Effect, Traffic Responsive Program, Special Function Status, Communications Status, Controller Status, System Detector Status, and Local Detector Status.

Local Intersections. The central-office computer software shall provide real-time information for any selected system intersection. The color display shall indicate the real-time operation of the local intersection in geometric representation and shall include:

- Status of all vehicle and pedestrian signals,
- Status of all vehicle and pedestrian detectors,
- Status of all 4 standard overlap signals,
- Status of all hold/omits and recalls,
- All 8 phase and special detector status conditions,
- All coded status and auxiliary output status,
- All preempt input status conditions, and
- Current intersection operational status, including mode and pattern-in-effect.

In addition, real-time color display of local controller unit status shall be provided and shall also include as a minimum an active ring timer status and simultaneous status display of all eight phases.

643.02.4.3--System Control: Uploading/Downloading. The central-office computer software shall have the capability of controlling system and/or intersection functions through its ability to download operational and/or timing parameters from a remote central-office site.

643.02.4.3.1--On-Street Masters. The central-office computer software shall provide remote timing parameter modifications, for any selected on-street master unit. Remote timing modification shall enable the user to upload master parameters for verification, modification, storage on disk, and/or printout. It shall provide the option of downloading new values to the master. Master parameters shall include as a minimum: Coordination, Traffic Responsive and Time Base parameters as well as Critical Alarm identification and assignment. Normal traffic control operations shall not be suspended during upload/download

activity between the central-office and the on-street master.

643.02.4.3.2.--Local Intersections. The central-office computer software shall provide remote timing parameter modifications for any selected local system intersection controller. Remote timing modification shall enable the user to upload local intersection parameters for verification, modification, storage on disk, and/or printout. It shall provide the option of downloading new values to the intersection. Local intersection parameters shall include all data specified in Subsection 643.02.2.7. As from the on-street master, the uploading/downloading operation between the central-office and the local intersection shall not suspend normal traffic control operations.

643.02.4.4--System Reports. The central-office computer software shall be capable of receiving system and intersection data from on-street masters and tabulate, format and output reports as described below:

643.02.4.4.1--Alarms. Critical operator designated alarm reports indicating local or master operating failures or other serious conditions shall be considered priority reports.

643.02.4.4.2--Sensor Volume Summary Reports. The central-office software shall be capable of tabulating, formatting and outputting sensor data from any of the system sensors. This data shall be obtainable on demand or output automatically as specified by the user. The reports shall be output on the color monitor and/or printer as selected by the user.

643.02.4.4.3--System Status Reports. The central-office computer software shall provide output reports, generated from data received from the on-street master and local intersection units, indicating system operating status including, but not limited to the following:

- (a) Intersection Status and Online/Offline History,
- (b) System and Local Detector Status,
- (c) Communications Status,
- (d) Controller Status,
- (e) System Program Changes by Group,
- (f) Traffic Responsive Pattern Selections, and
- (g) Performance Analysis, such as Speed and Measures of Effectiveness.

643.02.4.4.4--Sensor Graph. The central-office software shall have the capability to plot, in graphical form, detector data for at least eight system detectors by intersection. The graph shall display raw volume, raw occupancy, average percent volume and average percent occupancy along with associated interval time and corresponding raw data multipliers.

Reports shall be output on the color monitor and/or printer as selected by the

user. Any and all reports shall be obtainable on demand or output automatically as specified by the user. All report data shall be maintained on disk for future reference.

643.02.4.5--Operator Interface. The central-office computer software shall utilize the keyboard and the color graphic monitor of the personal computer as the primary interface between the operator and the system.

643.02.4.5.1--Data Entry/Display. All terminology shall be in English language/traffic engineering terms. No elaborate codes, special alphanumeric or complex procedures shall be required. A menu approach shall be utilized with appropriate prompts to allow an operator, unskilled in computers, the ability to operate the system.

Intersection and System parameters shall be organized and displayed in a tabular format with simple provisions for forward and back paging capability. Color shall be used exclusively to emphasize user changeable parameters and geometric displays as well as for highlighting instructional and descriptive areas of the display.

643.02.4.5.2--File Management. The central-office computer software shall provide for disk resident files of configuration data for all on-street masters and all local system intersections. These disk files shall be utilized to review configuration data without on-line activities, serve as a base line for modification prior to downloading new configuration parameters, or as a reference for comparison with uploaded configuration data.

643.02.4.6--Isolated Intersection Management Option. The central-office computer software shall include the capability of accessing system controllers at remote intersection locations. This capability shall include total access to all controller timing parameters, all intersection alarm conditions, all intersection performance measurements and statistical information, and access to all intersection status conditions in real time without the use of an on-street master.

This intersection management feature shall utilize the local system intersection controller with standard dial-up telephone circuits. The software package shall enable the Engineer to communicate with the isolated intersection in order to monitor current operation; record and analyze traffic conditions by time and pattern; modify, upload and download any controller program; and reduce maintenance cost.

The software package shall be user interactive and shall provide the Engineer total access to the complete files of timing and historical data for up to as many as 512 individual intersections. This access shall allow the Engineer the capability to review field maintenance needs over months or years and review traffic trends by day or hour within the day over a week or month period of

analysis.

643.02.5--Training Requirements. User training shall be provided by qualified instructors in Systems Operations and Systems Maintenance.

Personnel shall be trained to operate the system, analyze systems performance and revise critical operating parameters based on the analysis. This segment of the training program shall be a minimum of 16 hours duration.

Maintenance personnel shall be given training on maintenance and repair of all customer serviceable equipment. This segment shall include field level troubleshooting as well as bench repair. The duration of this segment of the training program shall be a minimum of eight hours.

643.02.6--Documentation. Complete system documentation shall be provided. Such documentation shall as a minimum consist of:

- Three complete systems operating manuals;
- Three sets of wiring diagrams and system block diagrams; and
- One copy of system operating software, resident on CDROM

643.02.7--Quality Provisions and Warranty. The On-Street Master, and the Communications equipment shall successfully meet the NEMA requirements as applicable.

The master unit shall be warranted to be free from defects in workmanship and material for two years from the date of shipment by the manufacturer. Any components found to be defective shall be replaced free of charge.

643.02.8--Software Updates. The supplier and/or manufacturer shall notify the user, in writing, whenever there is any modification or update to the closed loop on-street master system. Notification shall include an explanation of the changes made. If modifications to the software are released during the warranty period, the manufacturer shall provide the user the updates at no additional cost.

643.03--Construction Requirements.

643.03.1--System Turn-On. Prior to the system being turned on, the supplier is required to have input the appropriate phase, coordination, time base, preemption, system, alarms and communication data into the software's database. The data will be provided to the supplier by the Engineer. The supplier is also required to include in the database, a diagram of the overall, interconnected system.

At the time of the system turn on, qualified personnel familiar with the system operation and maintenance functions shall be present at the location of the central

office computer system to help in troubleshooting any problems should they occur.

643.04--Method of Measurement. Closed loop on-street master system will be measured as a unit quantity per each, such measurement being inclusive of the on-street master unit, housing, auto dial/auto answer modem, connectors, wiring, and central-office computer software and hardware, and including all materials, work, training, testing, and incidentals necessary for a complete and operable unit in place and accepted.

643.05--Basis of Payment. Closed loop on-street master system, measured as prescribed above, will be paid for at the contract unit price per each, which price shall include the installing, connecting, and testing, and for all equipment, labor, tools, and incidentals necessary to complete the work.

Payment will be made under:

643-A: Closed Loop On-Street Master System - per each

SECTION 644 - OPTICAL EMERGENCY VEHICLE PRIORITY CONTROL SYSTEM

644.01--Description. The system shall use optical communication to identify the presence of designated priority vehicles and cause the traffic signal controller to advance to and/or hold a desired traffic signal display selected from phases normally available. The system requires no attention of the vehicle operator other than a simple "emitter on" switch located in the vehicle which is to remain "on" until the emergency vehicle reaches its destination. The system shall operate on a first-come, first-served basis.

644.02--Materials.

644.02.1--General.

644.02.1.1--Matched System Components. The system shall be comprised of four (4) basic matched components:

- (a) Optical Emitter Assembly
- (b) Optical Detector
- (c) Optical Detector Cable
- (d) Traffic Signal Phase Selection System

644.02.1.2--System Requirements. Priority traffic signal phase selection shall be activated by an optically transmitted signal of fourteen thousand and thirty-five cycles per second (14.035 MHz) or upon the actuation of a test switch.

644.02.1.3--Adjustable Timing Capability. The system shall provide adjustable timing capability to insure adequate minimum traffic signal displays and timing when priority control is active.

644.02.1.4--Multiple Optical Detectors Input. The system shall provide for up to three (3) detectors for each channel to accomplish the following:

- (a) Sufficient time to deliver the desired traffic signal display in accordance with the minimum times required to terminate non-desired traffic signal displays.
- (b) Continuous contact between the optical emitter equipped vehicle and the phase selector unit due to line of sight obstructions.

644.02.1.5.--Safety Requirements. Abnormal display sequences such as "Red to Yellow to Red" will not occur. Transitions from green to red without a minimum three (3) second yellow change interval will not occur. The system shall cause the traffic signal controller to deliver the desired traffic signal display even if the optical energy signals are interrupted before the desired display is obtained. The system shall allow the traffic signal controller to resume normal timing operation after the desired signal display is obtained and optical signals cease.

644.02.2--Optical Detector.

644.02.2.1--General. The optical detector shall be a light-weight, weather proof device capable of sensing and transforming pulsed optical energy into electrical signals for use by the traffic signal phase selection equipment.

644.02.2.2--Functional Requirements. The optical detector unit shall perform the following functions and meet the requirements listed below:

- (a) The unit shall be high-impact polycarbonate construction with stainless steel and/or brass hardware. The unit shall be designed for easy mounting at or near an intersection on mast arm, pedestal, pole or intersection span wire.
- (b) The unit shall accept optical signals from two (2) directions and provide a single electrical output signal. The unit shall include a design feature to allow aiming of the two optical sensing inputs for hills, skewed approaches or slight curves.
- (c) The unit shall have built-in terminal strip to simplify wiring connections. The unit shall receive power from the traffic signal phase selector equipment and have internal voltage regulation to be operational from 16 to 40 volts AC.
- (d) The unit shall be responsive to the optical emitter at a distance of 1,800 feet. The unit shall deliver the necessary electrical signal to the traffic signal phase selector equipment via up to 1,000 feet of optical detector

cable.

- (e) The unit shall employ replacement circuit board assembly and photocells to facilitate repair.

644.02.3--Optical Detector Cable. The optical detector cable shall meet the requirements listed below:

- (a) The cable shall guarantee delivery of the necessary quality signal from the optical detector to the traffic signal phase selector equipment over non-spliced distance of 1,000 feet. The cable shall guarantee sufficient power to the optical detector over a non-spliced distance of 1,000 feet.
- (b) The cable shall be of durable construction for installation by direct burial, in conduit or mast arm, or exposed overhead supported by messenger wire. The weight of the cable shall have a minimum insulation rating of 600 volts and a temperature rating of 80°C.
- (c) The cable shall have three (3) conductors of AWG 20 stranded, individually tinned copper color coded as follows:
 - 1. Orange for delivery of optical detector power (+)
 - 2. Blue for optical detector power return (-)
 - 3. Yellow for optical detector signal

The conductors will be shielded with aluminized polyester and have an AWG #20 stranded and individually tinned drain wire to provide signal integrity and transient protection. The shield wrapping shall have 20% overlap to ensure integrity following conduit and mast arm pulls.

644.02.4--Traffic Signal Phase Selection Equipment.

644.02.4.1--General. The priority control system shall be capable of interfacing with electro-mechanical controllers and solid state controllers with or without internal priority control capability.

644.02.4.2--Phase Selector For Electro-Mechanical Controllers. The phase selector for electro-mechanical controllers shall:

- (a) Have solid-state logic with relay contact outputs.
- (b) Sense a minimum of five (5) yellow signal displays.
- (c) Sense the desired green phase for each channel.
- (d) Have front panel interval timing selections as follows:
 - 1. Green - one (1) to ten (10) seconds in one (1) second increments each channel.
 - 2. Yellow - one (1) to ten (10) seconds in one (1) second increments each channel.
 - 3. Shall have X2 switch to double timing and for both channels.
- (e) Have one (1) optical detector input per channel with expansion

capability up to four (4) per channel via an auxiliary detector coupling unit.

- (f) Have recessed range controls to adjust optical sensitivity.
- (g) Have solid-state light emitting diode (LED) indicators for "Power-On", "Signal" being received, Channel "A" or "B" call registered, and "Advance" circuit operation.
- (h) Have a test switch which operates to deliver an "A" or "B" channel call.
- (i) Have a switch to enable "Recall" to channel "A" after channel "B" call dropout for efficient resynchronization.
- (j) Have a control for adjusting the pulse width of the advance or manual pulses.
- (k) Have "commit to green" logic to insure delivery of desired green.
- (l) Be disabled during flash or preempt operation such as railroad, draw-bridge, etc.
- (m) Be capable of disabling local coordinators during priority calls.
- (n) Be capable of informing master controllers or computers that priority calls are being serviced.
- (o) Recognize signals from either a high or low priority optical energy emitter assembly.
- (p) Operate over a voltage range of 95 to 135 volts AC, 60 Hz.

644.02.4.3--Phase Selector For Solid-State Controllers. The phase selector for solid-state controllers shall:

- (a) Be a solid-state modular, microprocessor controlled, two (2) channel, four (4) phase, high priority electronic device expandable to four channel, eight (8) phase, dual-ring control.
- (b) Contain the optical recognition, traffic signal sensing and output circuitry to direct the controller towards the desired intersection signal displays utilizing existing controller inputs.
- (c) Have crystal controlled optical recognition and timing circuits.
- (d) Continuously monitor all Green, Walk and Pedestrian Clearance displays for smooth transition from controller to phase selector interval timing.
- (e) Have the following user settable timing available for all monitored displays.
 1. Green(s) - Zero (0) to nine (9) seconds in one (1) second increments.
 2. Walk(s) - Zero (0) to nine (9) seconds in one (1) second increments.
 3. Ped. Clear - Zero (0) to nine (9) seconds in one (1) second increments.
 4. "X2 Green" timing switch to double green timing and increments.
 5. "X2 Ped." timing switch to double ranges and increments.
- (f) Have the following user settable switches:
 1. "Ring Assignment" to match unit to controller configuration.
 2. "Desired Green(s)" for each channel to select from available

controller phases.

3. "Recall green(s)" to select from available controller phases upon priority call dropout.
- (g) Have capability for up to three (3) optical detector inputs per channel.
- (h) Have recessed range controls of three per channel to adjust optical detector sensitivity.
- (i) Have solid-state LED indicators for "Power-On", "Fault", "Advance", "Recall" active, and "Call" for each available channel which will flash during optical call validation and be steady-on during valid call registration and test switch operation.
- (j) Have "Test" switches to verify all Call and Recall functions.
- (k) Have capability to be disabled during flash or preempt.
- (l) Have opto-isolation on all controller interfacing outputs.
- (m) Monitor the 115-volt AC signals as delivered to the traffic displays.
- (n) Have opto-isolation on all signal display monitor inputs.
- (o) Be capable of disabling local coordinators during priority calls.
- (p) Be capable of informing master controllers or computers that priority calls are being serviced.
- (q) Have opto-isolation auxiliary outputs with relay drive capability which will be active during the following conditions:
 1. "Unit Active" - a Call or Recall activity is in progress.
 2. "Channel Active" - one (1) per available channel.
 3. "Call Satisfied" - the desired green(s) for the active channel is/are present.
 4. "Walk Active" - the unit is active and a Walk is being displayed.
 5. "Ped. Clear Active" - the unit is active and a Flashing Don't Walk is being displayed.
- (r) Be intended for interfacing with controllers with nominal 24-volt I/O logic levels and have the following capabilities:
 1. "Vehicle Calls" - always logic common.
 2. "Vehicle Skips" - always logic common.
 3. "Ped Skips" - always logic common.
 4. "Delayed Force-off" - logic common of +24 volts.
 5. "Stop Time" - logic common or +24 volts.
 6. "Advance" - logic common or +24 volts.
- (s) Have automatic thermo-resettable optical detector power protection.
- (t) Contain controller manipulation parameters within the unit to allow customization via switch selections and minor wiring variations.
- (u) Properly identify a high priority demand with one high priority emitter and any combination of up to nine low and high priority emitter signals being received simultaneously and asynchronously on any channel.

644.02.5--Reliability.

644.02.5.1--General. All equipment supplied as part of the emergency vehicle priority control system intended for use in the controller cabinet shall meet the

electrical and environmental specifications spelled out in the NEMA standards publication TSI-1983 Part 2.

644.02.5.2--Environmental Conditions. All equipment supplied as part of the emergency vehicle priority control system intended for use in or on emergency vehicles shall operate properly under any combination of the following environmental conditions:

- (a) Temperature Range: -30°F to +165°F
- (b) Relative Humidity: 0 to 95%

644.02.6--Documentation. After an award, the manufacturer or authorized representative shall be responsible for system documentation including the following:

- (a) Acquiring all relevant controller information.
- (b) Determine the number of vehicles phase, greens.
- (c) Determine the desired greens for priority approaches.
- (d) Determine ring configuration of controller.
- (e) Establish pedestrian requirements.
- (f) Establish minimum green times for non-priority phases.
- (g) Establish the manipulation method of each controller type.
- (h) Supply interface information to installer.
- (i) Assist in system checkout prior to acceptance by:
 - verifying proper installation per recommended interfaces.
 - verifying that optical ranges are properly set.
 - verifying that phase selector timings or controller software timings* are properly set.

* System checkout requirements when using the plug-in version of phase selector shall include verification that when two plug-in units are used, the controller shall recognize high priority over low priority and first-come, first-served. All possible conditions of priority control shall be considered. This may require software and/or hardware changes in the traffic controller. Software programming of these controllers is the responsibility of the purchasing/using agency.

- (j) Instruct emergency vehicle operators or their representatives in the operation of the system.
- (k) Instruct maintenance personnel in routine maintenance of the system.

644.02.7--Warranty.

644.02.7.1--General. Manufacturer shall warrant that, provided the priority control system has been properly installed, operated and maintained, component parts of a matched component system that prove to be defective in workmanship

and/or material during the first ten (10) years from date of shipment from manufacturer shall be covered in a documented system protection plan. The protection plan shall warrant that component parts of a matched component system that prove to be defective in workmanship and/or material during the first (5) years from date of shipment from manufacturer will be repaired at no charge and that extended coverage with a fixed repair deductible applies for an additional five (5) years. In total, the warranty coverage shall assure ten (10) year operational reliability and interface compatibility with future components designed for the system. A copy of the warranty outlining the conditions stated above shall be supplied with bid.

644.02.7.2--Certification. The manufacturer of the priority control system shall certify that all component products are designed, manufactured and tested as a system of matched components and will meet or exceed the requirements of this specification.

644.02.7.3--Annual Inspections. The manufacturer shall be required to send a representative to inspect each installation annually to test the system to insure it is in working order, and to document the test in a letter to the MDOT Traffic Engineering Division.

644.03--Construction Requirements. The emergency vehicle priority control system will be installed as part of the traffic signal system which it controls by the Prime Contractor and/or electrical sub-contractor. All installation requirements of the equipment manufacturer shall be followed unless otherwise directed by the Engineer. The completed installation shall present a neat and positive appearance and will not in any way interfere with the proper operation of the traffic signal system installation of which it is a part. The system manufacturer will provide all of the necessary system documentation as required to the installer and to the traffic signal equipment manufacturer so that installation of this system can be coordinated. All normal requirements for the installation of traffic signal controllers, and related equipment as outlined elsewhere in the specifications will be observed during the installation of this system.

644.04--Method of Measurement. Optical detector and phase selector of this system will be measured per each and will include all items and work necessary to complete the installation as shown on the plans. Optical detector cable will be measured by the linear foot. Measurement shall be computed horizontally along the conduit, messenger cable or mast arm which the cable is placed, from center to center of the several installations comprising the circuits. No extra length will be allowed for vertical measure of any kind; or for sag in aerial supported cable. The terminals for the measurements of lengths will be considered specifically as the center of the pull boxes, poles, optical detectors or controllers.

644.05--Basis of Payment. Optical detector, optical detector cable and phase

selector, measured as prescribed above, will be paid for at the respective contract unit price for each of the system components. Such prices shall be full compensation for furnishing, installing, connection and testing all materials; for pulling through conduit, mast arms and poles for attaching to messenger cable; for final cleanup; and for all labor, equipment, tools and incidentals necessary to complete the work.

Payment will be made under:

- 644-A: Optical Detector - per each
- 644-B: Optical Detector Cable - per linear foot
- 644-C: Phase Selector, ____ Channel(s) - per each

SECTION 645 - FLASHER ASSEMBLY

645.01--Description. This work consists of furnishing flasher assemblies complete in cabinet and installed in accordance with these specifications and the details shown on the plans.

645.02--Materials.

645.02.1--Material Requirements. Materials for flasher assemblies shall meet the requirements of the following Subsections:

Cabinets	722.13
Circuit Breakers	722.07

645.02.2--Performance Requirements.

645.02.2.1--General. Each flasher and its associated equipment shall be designed to operate on 115 volts, 60 Hz, single phase, alternating current. Variations in the voltage of the power supply of $\pm 10\%$, or sustained temperatures inside the cabinet between -20°F and 165°F shall not change the total flash rate. Heater elements shall not be used to attain compliance with these requirements. Traffic vibration shall not affect normal operations.

645.02.2.2--Specific Requirements.

645.02.2.2.1--Flasher Unit. Each flasher unit shall be flashed at not less than 50 nor more than 60 flashes per minute, with approximately 50 percent dwell time. A two circuit flasher mechanism, alternate flash, and three flasher field circuits for each of the two flasher circuits will be required.

The flasher unit shall meet the requirements of NEMA Standard Publication TS-1-1983 Traffic Control Systems, Section 8. The flasher outputs shall be rated at 15 amps.

645.02.2.2.2--Wiring. All wiring shall be neatly bundled and secured with plastic cable ties. All terminals shall be labeled. All leads shall be identified by stamped aluminum or printed plastic labels to correspond with the plans. The outgoing signal circuits shall be of the same polarity as the line side of the power supply, and the common return of the signal circuits shall be of the same polarity as the ground side of the power supply. The ground side of the power supply shall be carried throughout the flasher in a continuous circuit and shall be secured to a ground bus bar in an approved manner. All conductors shall be terminated in the flasher cabinet by means of a pressure grip two pole molded insulated barrier terminal strip(s) of sufficient physical and electrical capacity. The terminal strip(s) shall be mounted horizontally on the inside of the cabinet back approximately three inches from the bottom of the cabinet. All wiring to the terminal strip(s) except the incoming field circuits shall be performed by the controller manufacturer. The terminal strip(s) shall mount at least:

- (1) Two terminals for the power supply.
- (2) An unfused terminal for neutral side of power supply line.
- (3) One terminal for each signal lamp circuit and one terminal for the common return from each signal face.

An approved lightning arrester shall be installed in each cabinet adjacent to the terminal strip used for grounding.

645.02.3--Flasher Cabinets. Cabinets shall be minimum 0.185-inch cast aluminum, sheet aluminum or minimum of 0.080-inch reinforced sheet steel, and shall be of clear-cut design and appearance. The cabinet shall provide ample space for housing all equipment and components. Unless otherwise specified, controller cabinets shall be at least 12 inches wide by 13 inches high by 10 inches deep.

Doors. A hinged door or doors shall provide complete access to the interior of the cabinet. The door(s) shall fit against a rain-tight gasket. The door(s) shall be provided with a cabinet lock and shall have stamped or raised outside designation, "Traffic Control", or other approved identification. Two keys shall be furnished for each type lock used. The door hinges and pins shall be of corrosion resistant metal. Pins shall be solid rod, at least 1/8 inch diameter, except if continuous hinges are furnished, the pins shall be continuous the full length of the hinges and shall be not less than 1/16 inch diameter.

645.03--Construction Requirements.

645.03.1--Construction Details. The flashers in cabinet shall be installed at the

locations and as indicated on the plans and in conformance with the requirements herein stated.

645.03.2--Tests and Warranties. After completion of flasher units, the Contractor shall demonstrate by tests to the Engineer's satisfaction that:

- (1) all circuits are continuous and free from short circuits,
- (2) that all circuits are free from unspecified grounds,
- (3) that the resistance to ground of non-grounded conductors is at least one megohm at 60°F measured with a 1000 ohms per volt megger, and
- (4) that the ground resistances are not more than 25 ohms.

645.04--Method of Measurement. Flasher assembly will be measured as a unit quantity per each, which measurement shall include all items necessary to complete the installation.

645.05--Basis of Payment. Flasher assembly, measured as prescribed above, will be paid for at the contract unit price per each, which price shall be full compensation for furnishing all materials, for all construction, erecting, installing, connecting; for cabinets, flashers, circuit breakers, ground wire, straps, entrance fittings, for final cleaning up and for all equipment, tools, labor and incidentals necessary to complete the work.

Payment will be made under:

645-A: Flasher Assembly - per each

SECTION 646 - REMOVAL OF EXISTING TRAFFIC SIGNAL EQUIPMENT

646.01--Description. This work consists of removing all existing traffic control equipment that will no longer be required.

646.02--Blank.

646.03--Construction Requirements. Existing traffic signals, traffic controllers, span wires, control wires, interconnect cable, etc. will be removed by the Contractor. Existing traffic signal support poles that are no longer required and have no other utilities attached will be removed. The Contractor shall restore areas disturbed by the removal of the existing equipment to the satisfaction of the Engineer.

When salvaged by the State, all removed equipment will be identified by a tag noting its location and date of removal. The Engineer shall be informed of the items removed, their location and date of removal. Removed items will be stored

on the project and the Contractor shall notify and coordinate with the State for the return of salvaged traffic signal equipment. Unless otherwise noted in the contract, all loading and hauling of State-salvaged traffic signal equipment will be the responsibility of the State.

646.04--Method of Measurement. Removal of existing traffic signal equipment will be measured as a unit lump sum quantity. Such measurement shall include removal, any required tagging and storing of signal equipment, span wire, interconnect cable, etc.

646.05--Basis of Payment. Removal of existing traffic signal equipment, measured as prescribed above, will be paid for at the contract lump sum price, which price shall be full compensation for removal and disassembly of existing traffic signal equipment, for restoration of areas disturbed by removal and for furnishing all equipment, tools, labor and incidentals necessary to complete the work.

Payment will be made under:

646-A: Removal of Existing Traffic Signal Equipment - lump sum

SECTION 647 - PULL BOXES

647.01--Description. This work consists of furnishing all materials required to install pull boxes at locations indicated on the plans in conformity with the plans and these specifications.

647.02--Materials. Pull boxes shall meet the requirements of Subsection 722.06.

647.03--Construction Requirements. The cover elevation of pull boxes shall be flush with sidewalks and approximately one inch above earth or sodded areas. Positions of pull boxes are shown on the plans in their relative positions only and may be repositioned with the approval of the Engineer or inspector to suit local conditions. If a pull box is shown to be installed in soil, a concrete collar shall be poured, as shown by detail on the plans, to ensure firm placement.

647.04--Method of Measurement. Pull box of the type specified will be measured as a unit quantity per each.

647.05--Basis of Payment. Pull box, measured as prescribed above, will be paid at the contract unit price per each, which price shall be full compensation for furnishing materials; for installing and final cleanup; and for all equipment, labor, tools and incidentals necessary to complete the work.

Payment will be made under:

647-A: Pull Box, Type

- per each

SECTION 648 - RADIO INTERCONNECT

648.01--Description. This work consists of adding radio interconnect capabilities to local and master controller locations in lieu of hard wire interconnect.

648.02--Materials. Each local intersection shall have a local transceiver, power supply and an antenna. A special transceiver antenna shall be provided at the master location.

648.02.1--RF Data Link for Local Controller Communication. Communications between the master and the local intersections shall be performed via RF Data Link. The radio signal communication shall be done in the 900-MHz data frequency bands.

648.02.2--Repeaters.

648.02.2.1--Specific Requirements.

648.02.2.1.1--Antennas. Two antennas are required at repeater stations, one for each radio. Measures must be taken to minimize the chance of interference between these antennas. One effective technique for limiting interference is to employ vertical separation. In this arrangement, one antenna is mounted directly over the other, separated by at least four feet. This takes advantage of the minimal radiation exhibited by most antennas directly above and below their driven elements.

Another interference reduction technique is to cross-polarize the repeater antennas. If one antenna is mounted in the vertical plane, and the other in the horizontal plane, an additional 20 dB of attenuation can be achieved. Remember that the corresponding stations must use the same antenna orientation when cross-polarization is used.

648.02.2.1.2--Interface Wiring. A null modem cable is required between the Data Interface connectors of the two radios forming a repeater station. This allows them to freely exchange data even though they are both configured as DCE devices.

648.03--Construction Requirements. The Contractor will be responsible for verifying the integrity of the communication links between the local intersections and the master.

648.04--Method of Measurement. Radio interconnect and repeater installation

will be measured as a unit quantity per each. Measurement shall include controller/master modifications, transceiver, power supply, antenna and all other items necessary to complete the installation to provide appropriate RF Data Link.

648.05--Basis of Payment. Radio interconnect and repeater installation, measured as prescribed above, will be paid for at the contract unit price per each for each type(s) specified in the contract; which price shall be full compensation for furnishing all materials; for installing, connecting and testing; and for all equipment, labor, tools, and incidentals necessary to complete the work.

Payment will be made under:

- 648-A: Radio Interconnect, Installed in New Controller Cabinet - per each
- 648-B: Radio Interconnect, Installed in Existing Controller Cabinet - per each
- 648-C: Radio Repeater Installation - per each

SECTION 649 - VIDEO VEHICLE DETECTION

649.01--Description. This work consists of furnishing all component materials required to enable video detection capabilities to traffic signal locations in lieu of other methods of vehicle detection and assembling, constructing, erecting, and installing same in conformity with these specifications, to insure properly operating unit(s) in accordance with the design(s) and at the locations shown on the plans or as directed. The video vehicle detection system shall detect vehicles on a roadway using only video images of vehicle traffic and provide detector outputs to a traffic controller or similar device.

649.02--Materials. Each location shall have one to four video image sensors as required, isolation amplifiers for video cabling, a control unit, and a pointing device. The system shall include personal computer software which allows detection of vehicles in multiple lanes using only video images.

649.02.01--Functional Capabilities. The control unit shall process video from up to four video sources simultaneously. The sources may be video image sensors or video tape players. The video signal shall be input to the control unit in RS 170 format. The video signal shall be digitized and analyzed in real time.

The control unit shall detect the presence of vehicles in up to 24 detection zones per image sensor. Each detection zone shall be approximately the width and length of one car. Detector zones shall be programmed via a menu displayed on a video monitor and a pointing device connected to the control unit. The menu shall facilitate placement of the detector zones. A separate computer shall not be required for programming detection zones.

The control unit shall store up to five different detector zone patterns for each image sensor field of view. The control unit shall be able to switch to any one of the up to five different detector zone patterns within one second of user request via menu selection with the pointing device. The control unit shall detect vehicles in real time as they travel across each detection zone.

The control unit shall have an RS232 port for communications with an external computer. The control unit shall accept new detector patterns from an external computer through the RS232 port, when the computer uses the correct communications protocol for unloading detector patterns.

649.02.02--Vehicle Detection. A total of up to 144 individual detection zones shall be supported. A single detection zone shall be capable of replacing multiple loops, and detection zones may be associated together by a Boolean logical or function to indicate vehicle presence on a single phase of traffic movement. Placement of detection zones shall be done by using only a pointing device and a graphical interface built into the control unit to draw the detection zones on the video image from each video image sensor. Detection zones shall be allowed to overlap one another. Up to five detection zone patterns shall be saved for each image sensor within the control unit memory, and this memory shall be protected from loss during power outages. Selection of the detector zone pattern for current use shall be done through a menu. When a vehicle is detected crossing a detector zone, the detector zone shall flash a symbol on the video image to confirm the detection of the vehicle.

Detection shall be no less than 99% accurate in good weather conditions, and no less than 96% accurate under adverse weather conditions such as rain, snow, or fog. Detection accuracy is dependent upon image sensor quality and placement, and these accuracy levels do not include allowances for occlusion or poor video due to image sensor location or quality. Detector placement from the image sensor shall not be more than the distance of ten times the mounting height of the image sensor. The control unit shall provide vehicle presence detection through either a NEMA TS1 or NEMA TS2 port.

649.02.03--System Hardware. The control unit shall be housed in a durable metal enclosure suitable for shelf mounting in a roadside controller cabinet. When mounted outdoors in the enclosure, the image sensor shall operate satisfactorily within the environmental conditions specified in NEMA Standards TS-1 Section 2. Surge ratings shall be as set forth in the NEMA TS2 specification.

The control unit shall include a RS232 port for serial communications with a remote computer. This port shall be a 'D' subminiature connector on the front of the control unit. The control unit shall include a port for transmitting detections to a traffic controller. This port shall be a 'D' subminiature connector on the front of the control unit.

The front of the control unit shall include four BNC video inputs for RS 170 video. Each video input shall include a switch selectable 75-ohm or high impedance termination to allow video to be routed to other devices, as well as input to the control unit for vehicle detection.

The front of the control unit shall include one BNC video output. Any one of the four video inputs shall be selectable for output on this BNC connection via the pointing device at the control unit, or through software and a personal computer connected to the RS232 port via a full duplex modem link. The video inputs to the control unit shall include transient voltage suppression and isolation amplification that shall assure the 1-volt peak-to-peak video signal integrity is maintained despite video cabling losses and externally induced transients.

The control unit enclosure shall be bonded to good earth ground.

649.02.04--System Image Sensor. The video cameras used for traffic detection shall be furnished by a control unit supplier and shall be qualified by the supplier to ensure proper video detection system operation. The image sensor shall produce a usable video image of vehicles under all roadway lighting conditions, regardless of time of day. The minimum range of scene luminance over which the image sensor shall produce a usable video image shall be the minimum range from night time to day time for the site, but not less than the range from 0.1 lux to 10,000 lux. The image sensor shall use a CCD sensing element, and shall output monochrome video with resolution of not less than 350 lines vertical and not less than 500 lines horizontal.

The camera shall include auto-iris control based upon average scene luminance and shall be equipped with an auto-iris lens with focal length and maximum aperture selected to suit the deployment site. The lens auto-iris shall be adjusted to minimize image variations. The image sensor shall include automatic gain control to produce a satisfactory image at night.

The image sensor shall be housed in an environmentally sealed enclosure pressurized with dry gas to minimize the formation of condensate and extend the life of the image sensor and lens. The image sensor enclosure shall be equipped with a sunshield that prevents sunlight from directly entering the lens. The sunshield shall include a lip to prevent water and ice from entering the image sensor field of view. The image sensor enclosure shall include a thermostatically controlled heater to assure proper operation of the lens iris at low temperatures and prevent moisture condensation on the optical face plate of the enclosure. When mounted outdoors in the enclosure, the image sensor shall operate satisfactorily within the environmental conditions specified in NEMA Standards TS-1 Section 2.

The image sensor shall be powered by 120-VAC 60-Hz, or 220-VAC 50-Hz power. The image sensor enclosure shall be equipped with separate weather tight

connectors at the rear of the enclosure for power and video to allow diagnostic viewing of video at the image sensor while the image sensor is mounted and powered-up on a mast arm or pole. The video signal output by the image sensor shall be in RS 170 format. The video signal shall be fully isolated from the image sensor enclosure and power cabling.

649.03--Construction Requirements.

649.03.01--Installation. The supplier of the video detection system shall furnish complete documentation describing installation requirements within 10 days of placement of order. Such documentation shall include descriptions of all required cabling, mounting hardware, image sensors, cabinet space, and power. Suitable video cabling and connections shall be installed to ensure the video signal losses between each image sensor and the control unit do not exceed 3 db. All power cabling shall be installed to comply with the National Electrical Code, as well as local electrical codes.

The Contractor shall provide factory certified technicians to set detector zones initially and to adjust the zones as required should the project have multiple phases in the traffic control plan.

649.03.02--Contractor Training. Installation of the video detection system shall be as recommended by the supplier and performed by a Contractor trained and certified by the supplier. Where time does not reasonably permit training of the installing Contractor, a supplier factory representative shall supervise and assist a Contractor during installation of the video detection system.

649.03.03--User Training. The supplier of the video detection system shall provide an eight-hour operations and maintenance training class with suitable documentation for up to five persons selected by the Department. The operations and maintenance class shall be scheduled at a mutually acceptable time and location.

649.03.04--Warranty. The video detection system shall be warranted to be free of defects in materials and workmanship for a period of two years from date of shipment. During the warranty period, the supplier shall repair or replace with new or refurbished material, at no additional cost to the State, any product containing a warranty defect, provided the product is returned postage-paid by the Department to the supplier's factory or authorized warranty site. Products repaired or replaced under warranty by the supplier shall be returned with transportation prepaid by the supplier.

During the warranty period, technical support shall be available from the supplier via telephone within four hours of the time a call is made by the Department, and this support shall be available from factory certified personnel. During the warranty period, updates and corrections to control unit software shall be made

available to the Department by the supplier at no additional cost.

649.03.05--Maintenance and Technical Support. The supplier shall maintain an adequate inventory of parts to support maintenance and repair of the video detection system. Spare parts shall be available for delivery within 30 days of placement of an acceptable order at the supplier's then current pricing and terms of sale of said spare parts.

The suppliers shall maintain an ongoing program of technical support for the video detection system. This technical support shall be available via telephone or via personnel sent to the installation site upon placement of an acceptable order at the supplier's then current pricing and terms of sale of said technical support services.

649.04--Method of Measurement. Video vehicle detection will be measured as a unit quantity per each for each type of video vehicle detection system installation. Measurement shall include controller modifications, hardware, connectors, wiring, software, incidentals, and all other items necessary for a complete and operable unit in place and accepted.

649.05--Basis of Payment. Video vehicle detection, measured as prescribed above, will be paid for at the contract unit price per each video vehicle detection system installed, which price shall be full compensation for furnishing all materials, for installing, connecting and testing, and for all equipment, labor, tools, and incidentals necessary to complete the work.

Payment will be made under:

649-A: Video Vehicle Detection, New Installation, ____ Cameras - per each

649-B: Video Vehicle Detection, Existing Installation, ____ Cameras - per each

SECTION 650 - ON-STREET VIDEO EQUIPMENT

650.01--Description. This work shall consist of furnishing and installing equipment necessary for a complete working system of on-street traffic monitoring video. The system shall support complete access from the local traffic agency as well as access from the MDOT state-wide traffic management system. The traffic video system shall provide all components and integration required for full operation including, but not limited to, on-street camera equipment, communication links & equipment, and central office materials & equipment.

High resolution, color outdoor, dome-type camera units shall be compatible with MDOT's existing switched video control system located at the MDOT Traffic Management Center (TMC). All components, cabling, integration and

installation necessary to make the camera site and local agency video management site fully functional with the State's existing video system shall be furnished by the Contractor. It is the purpose of this specification to set forth the minimum requirements for traffic monitor video systems to be used in the State's Advanced Traffic Management Systems (ATMS).

650.02--Materials. The outdoor camera unit shall be an outdoor, dome-type high resolution, NTSC camera assembly. The camera assembly shall be rugged and incorporate the latest CCD technology. The dome camera assembly shall include an intelligent, compatible architecture design to ensure that the system will adapt to future technologies.

The dome camera assembly shall include a smooth pan rate that delivers zoom without image jitter or jump. The unit shall include auto-focus. The unit shall include 360 degrees of rotation, continuous in both directions with variable speed and fast speed capability.

The dome camera assembly shall include 16X optical zoom and 8X electronic magnifier features thereby delivering the power of 128X zoom.

The dome assembly shall include a universal design allowing it to be used in varied configurations and with several mounts including, but not limited to, side-of-pole, corner, and flat mounting situations.

The dome camera assembly shall include a clear shatterproof globe with hard-coat for cloth cleaning without scratches. The dome camera assembly shall be equipped with sun shield, heater and ozone impervious seals.

The dome camera assembly shall provide a total integrated camera solution that can integrate with the State's ITS architecture.

Integrated multiple video switch support shall be included. This support shall provide the benefit of intelligent, compatible architecture, which allows the system to adapt to future video switching technologies.

The dome camera shall provide performance that exceeds the preset pan speed of 500 degrees per second. The dome camera shall be capable of multiple tours that provide numerous views.

During manual control, the camera assembly shall provide an adaptive, real-time system that delivers a smooth response and allows one to zoom in on objects without jitter and picture jump. The dome camera assembly shall include a universal clamp-in design and on-board protocols that interface with various popular video control systems.

The dome camera assembly shall include on-board diagnostics and nonvolatile

memory that keeps track of all maintenance. The diagnostic systems and time-date maintenance system shall help ensure that the system operates at peak efficiency.

The dome camera assembly shall include a minimum of eight (8) alarm inputs and outputs. The unit shall be addressable for up to 254 addresses. The unit shall include communication support for RS-232, RS-485, and RS-422 standards.

The dome shall include a character generator and shall support a height of 18 scan lines. Position shall be 24 characters, 12 lines per field, and available top to bottom or right to left. Color and black & white operation shall be selectable. Date line shall include multiple formats with a selectable time line of 12 or 24 hour clock. The dome assembly shall include up to 24 zone titles and the unit shall be software and hardware field upgradable.

The dome camera assembly shall include a minimum one-year manufacturer's warranty. All manufacturer's warranties and guarantees on all electrical and mechanical equipment shall be delivered to the Engineer at the final inspection. All warranties and guarantees shall be made out to the MDOT and shall begin after final acceptance of the project.

The dome camera assembly shall be capable of interfacing with the State's Video System Controller, Advanced Traffic Management System (ATMS), and Traffic Communication Network.

650.03--Construction Requirements. The on-street video camera(s) shall be installed at the location(s) shown on the plans. The camera(s) shall be installed in accordance with the manufacturer's recommendation, these specifications or as directed by the Engineer.

650.04--Method of Measurement. On-street video equipment, constructed and installed as specified in the plans will be measured per each camera installation. Such measurement shall be inclusive of camera unit, housing, pan/tilt drive, receiver/driver, mounting hardware and any enclosures necessary. It shall also include any items necessary to mount the camera unit from a mast arm pole, steel strain pole, pole extension pipe, etc.

650.05--Basis of Payment. On-street video equipment, measured as prescribed above, will be paid for at the contract unit price bid per each, which price shall be full compensation for furnishing all materials, for all installing, connecting, cutting, pulling and testing and for all equipment, tools, labor and incidentals necessary to complete the work.

Required cabinet facilities, including transformer and/or disconnects, will not be measured for separate payment.

Payment will be made under:

650-A: On-Street Video Equipment *

- per each

* Type may be specified as an option

SECTION 653 - TRAFFIC AND STREET NAME SIGNS

653.01--Description. This work shall consist of furnishing and installing reflectorized regulatory and warning traffic signs and street name signs as shown on the plans and set forth herein.

This specification addresses the minimum requirements for supplying traffic and street name signs for use with span wire and mast arm mounted traffic signal systems.

653.02--Materials. All materials for traffic and street name signs shall be new and meet the requirements of Section 721 of the Standard Specifications.

653.02.1--Reflective Sheeting. Reflective sheeting for traffic and street name signs shall be Type III or Type VII retroreflective sheeting. The type and color of reflective sheeting shall be indicated on the plans or set forth herein.

653.02.2--Sign Blanks. Sign blanks shall be flat aluminum sign blanks constructed of 5052-H38 aluminum alloy. Blanks shall be 0.100 inches thick, degreased, deburred, etched and alodine. Sizes shall be as indicated in the plans for the specific warning, regulatory or street name sign called for and to accommodate the various legends.

653.02.3--Sign Faces. All sign faces shall consist of sheeting material and their legends applied to aluminum blanks specified herein using a heat vacuum method and/or by silk screening the legends only onto the backings and material. The sheeting shall be applied with legends to one side of each warning, regulatory or street name sign as shown on the plans.

The color of all faces shall consist of a reflectorized yellow, red, green or silver-white background with reflectorized black, red or white legend. The legend shall consist of letters and symbols conforming to the design of warning or regulatory signs as shown in the MUTCD and for street name signs as shown on the plans.

All letter sizes spacing shall be in accordance with FHWA and the manufacturer's recommendations to insure proper legibility with the increased reflectance.

653.03--Construction Requirements. All signs shall be installed in accordance with the plans and the Manual on Uniform Traffic Control Devices (MUTCD).

Signs are to be tilted in order to minimize or eliminate specular reflection.

653.03.1--Warning and Regulatory Signs. Warning and regulatory signs shall be installed at locations as noted on the plans with the appropriate mounting bracket and banding material.

653.03.2--Street Name Signs. Street name signs shall be installed at locations as noted on the plans. If installed on mast arms, they shall be attached with at least two mounting brackets and appropriate banding materials.

653.03.3--Washers. Washers, if recommended by the sheeting manufacturer to protect the sign surface from damage by bolts or other fasteners, shall be furnished by the manufacturer at no additional charge.

653.04--Method of Measurement. Traffic sign and street name sign of the type specified will be measured by the square feet, which measurement being inclusive of aluminum sign blank, applied reflective sheeting, mounting brackets and banding materials and begin inclusive of all materials, work and services necessary for a properly constructed sign.

653.05--Basis of Payment. Traffic sign and street name sign, measured as prescribed above, will be paid for at the contract unit price per square feet, which price shall be full compensation for furnishing the sign and mounting hardware and installing the same on the span wire, signal pole or mast arm, and for all equipment, tools, labor and incidentals necessary to complete the work.

Payment will be made under:

653-A: Traffic Sign, Type - per square feet

653-B: Street Name Sign, Type - per square feet

SECTION 657 - FIBER OPTIC CABLE (OSP)

657.01--Description. All outside plant trunk cables shall be stranded loose tube design. Drop cables shall be central core or stranded loose tube design. The cable configurations shall be dictated by the particular communication path, data rate, and distance of the optical path. Three possible designs are all multimode fiber, all single mode fiber cable, or a hybrid design containing multimode and single-mode fiber. In the case of a stranded loose tube hybrid design, single-mode and multimode fibers shall not occupy the same buffer tube. Single-mode tubes shall be placed in the first available tubes in the cable, i.e., blue, orange, etc., based on cable design, multimode tubes shall follow.

657.02--Materials. The fiber optic cable shall meet the requirements of

Subsection 722.21, the United States Department of Agriculture Rural Utilities Services (RUS) 7 CFR1755.900 and the ANSI/ICEA Standard for Fiber Optic Outside Plant Communications Cable, ANSI/ICEA S-87-640-1992.

The cable shall be new, unused, and of current design and manufacture.

657-03--Construction Requirements.

657.03.1--Pre-Terminated Drop Cable Assemblies. These assemblies shall be employed when connecting a camera, controller, VMS or other device the main cable when mid-span access techniques are used.

Cable used for Drop cable assemblies shall conform to Subsection 722.21.4.

Assemblies shall be factory assembled and terminated on one end with ceramic ferrule, ST compatible, heat cured epoxy connectors with an operational temperature of -40°F to +160°F. Each connector shall have a minimum of a 1-inch strain relief boot.

Insertion loss for each connector shall not exceed 0.30 dB for both single mode and multi-mode assemblies. Return loss for single mode connectors shall be >-45dB. Each assembly is to be fully tested and those test results placed on a test tag for each assembly. Each assembly is to be individually packaged within a box or reel, with the submitted manufacturer's part number marked on the outside of the package.

Individual 250 µm coated fibers shall be up-jacketed to 1/8-inch using fan-out tubing. This tubing shall contain a 900 µm Teflon inner tube, aramid yam strength members, and an outer jacket. The fan-out tubing shall be secured to the cable in an hard epoxy plug transition. Length of the individual legs shall be a minimum of three feet with the length difference between the shortest and longest legs of the assembly being no more than two inches.

657.03.2--System Configuration.

657.03.2.1--Drop and Insert Applications. Signal from the MDOT Traffic Management Center (TMC) to local controllers, cameras, and/or variable message signs will be conveyed via the backbone and branch cables in a closed loop configuration. At each controller, the applicable fibers will be routed in and out of the applicable housing via a mid-span access splice point and a pre-terminated drop cable. Only fibers required for the drop and insert shall be cut, no other fibers in the cable shall be cut without the direction of the Engineer.

Fibers shall be routed to equipment via an Aerial Drop Cable Kit, PN DK111-B0431-XXX or Undergrade Drop Cable Kit, PN DK211-B0431-XXX or approved equal; where XXX denotes length of drop pigtail in feet. Drop Kit

shall contain appropriate closure, splice tray, splice protection, and a preterminated drop cable of specified length, and shall also include a 12-port fiber distribution cabinet and appropriate interconnect adapters and jumpers. Shall also include a 12 port fiber distribution cabinet and appropriate interconnect adapters and jumpers. Splicing shall be fusion or mechanical. Splice loss in either case shall be 0.25 dB, measured in one direction only with an OTDR at 850 nm for multi-mode and 1310 for single-mode.

The type of mechanical splice, if used, shall be approved by the Engineer prior to use. The splice shall be stored in a splice organizer/tray specifically designed for the mechanical splice used. Fusion splices shall be protected using heat shrink protective sleeves and stored in a splice organizer/tray specifically designed for the protection device.

657.03.2.2--Point-to-Point Applications. Signal to the local controllers will be conveyed by routing fiber optic cable directly between equipment with an appropriate fiber count cable and be directly terminated with field installable ST compatible connectors. At the end points, the cable shall be terminated via one of two methods.

For Direct Connect Applications. The fiber optic cable shall be terminated using a Spider Fan-out Kit. Any substitute termination method must have at a minimum 24 inches of 1/8-inch fan-out material jacketing for fiber protection, provide for central member strain relief, provide for antirotation and pull out. Field installable ST compatible connectors will be terminated on the fan-out and connected directly to the transmission equipment.

For Cross Connect Applications Inside Controller Cabinets. The fiber optic cable shall be terminated using a 900- μ m fanout modular design for the fiber count being terminated. The non-metallic fan-out shall attach directly to the buffer tube and transition the 250 μ m coated fibers into the fan-out tubing. The fanout shall be housed in a wall mount distribution cabinet equipped with the appropriate number of adapters. The fibers shall be connected to the transmission equipment via ST/ST fiber optic patch cables. This hardware scheme shall also be utilized for wall mount applications.

657.03.2.3--Fiber Optic RS-232 Communications.

Fiber Optic Data Transceiver. The transceiver(s) shall be located at the TMC and communicate directly with the traffic controllers in the closed loop system(s). They shall be rack mountable. The fiber optic data transceiver shall be compatible with the internal modem(s) installed internally in each traffic controller. The unit shall provide transmission of RS-232 data signals over standard 62.5/125 multi-mode fiber optic cable. Transceiver shall have L.E.D. receive and transmit indicators. Transceivers shall be capable of being linked together in either repeater or star configurations. Unit shall provide for

transmission distances of up to 13,000 feet without requiring manual adjustments or line attenuators . All printed circuit boards shall be manufactured from Mil Grade specification circuit board material. Housing shall be all metal construction with all connections identified with silk screened labels. Unit shall be available in both rack mount and surface mount versions. Units shall have solid state limiters on all power lines which shall provide for automatic reset. Rack mount configurations shall have an internal D.C. power supply and a short circuit in one unit shall not affect the operation of other units powered from the common power supply. Rack mount units shall be hot swappable with no risk of damage to other units during replacement. Transceiver shall be U.L. listed and shall have the following features and characteristics:

Data Rate	DC-64 kbaud - NRZ
Wavelength	850 nm
Number of Fibers	2 fibers
Size, inches	4.2 x 3.5 x 1.0; Rack Mount: 7.7 x 5.0 x 1.0
Operating Temperature	-5°F to +160°F
Bit Error Rate	1 in E+9
Operating Mode	Asynchronous, simplex, or full duplex
Input/Output Level	±3.75 to ±12 volts
Input/Output Impedance	Per RS-232 specification
Optical Budget	14 dB; less 4 dB for 50/125 fiber
Output Power	25 W @ -16 dBm
Input Sensitivity	1 W @ -30 dBm

Connectors:

Optical	AT&T type ST
RS-232	Female plug with screw clamps or adapter to DB-9 connector

Power:

Rack	115 VAC ±10%, 60 Hz PS-12 DC
Stand-alone	115 VAC ±10%, 60 Hz with module or +9 to 15 VDC @ 100mA

Fiber Optic Rack Mount Enclosure. The fiber optic rack shall be compatible with the RS-232 transceivers above. The unit shall provide 14 mounting slots for standard 1-inch wide rack mount version fiber optic modules. It shall have heavy duty construction and shall mount in industry standard equipment racks that accommodate 19-inch wide rack mount panels. Unit shall include a 20 VAC C.T. transformer power supply. All compatible rack mount fiber optic modules shall have an internal D.C. power supply with solid state limiters which provide automatic reset and a short circuit in one unit shall not affect operation of other units powered from the common power supply. Modules shall be hot swappable with no risk of damage to other units during replacement. Rack shall be U.L. listed and shall have the following features and characteristics:

Input Voltage	115 VAC - line cord
Power Supply	20 VAC C.T. @ 2.8A
Number of Module Slots	14 slots
Size, inches	19.0 W x 5.2 H x 7.0 D
Operating Temperature	-5°F to +160°F
Fusing	1 A slow-blow; plug-in modules individually fused

657.03.3--Fiber Optic Patch Cables - Jumpers. Any patch cords used for system configuration shall be compatible with fiber types and connectors specified herein. Multimode patch cords shall be orange in color. Single-mode patch cords shall be yellow in color. Jacketing material for both shall conform to the appropriate NEC requirement for the environment in which installed. All cordage shall incorporate a 900-μm buffered fiber, aramid yam strength members, and an outer jacket. Patch cords may be simplex or duplex, depending on the application. Multimode cordage attenuation shall be 3.75 dB/km @ 850 nm, 1.5 dB/km @ 1300 nm; for single-mode fibers shall be 1.0 dB/km @ 1310 nm, 0.75 dB/kin @ 1550.

657.03.4--Fiber Optic Connectors. All connectors used in the communication system shall be ST compatible, ceramic ferrule connectors. Factory terminated connectors shall be heat cured epoxy type with a maximum measured loss of 0.30 dB; Field installable connectors may be heat cured epoxy or no polish cleave and crimp technology, with a maximum measured loss of 0.50 dB per mated pair. The operating temperature of all connectors in the system shall be -40°F to +160°F with no more than a 0.20 dB change across the temperature range.

657.03.5--Fiber Optic Closures.

657.03.5.1--OSP Closures for Aerial, Pole Mount, Pedestal, and Hand Hold Environments. OSP closures for aerial, pole mount, pedestal, and hand hold shall be capable of accepting up to six cables in a butt splice. The closures shall be capable of storing up to eight 90-inch lengths of expressed buffer tubes.

Assembly shall be accomplished without power supplies, torches, drill kits or any special tools. Reentry shall require no additional materials. Sealing shall be accomplished by enclosing the splices in a polypropylene dome that is clamped together with a stainless steel latch and sealed with an O-ring.

Closure shall be capable of strand mounting with the addition of a strand mounting bracket.

Splice case shall be non-filled, non encapsulate to prevent water intrusion and shall allow re-entry without any special tools. The closure shall be capable of preventing a 10-foot water head from intruding into the splice compartment for a period of seven days. Testing of the closure is to be accomplished by the placing

of the closure into a pressure vessel and filling the vessel with tap water to cover the closure. Continuous pressure shall be applied to the vessel to maintain a hydrostatic head equivalent to 10 feet on the closure and cable. This process shall be continued for seven days. Remove the closure, open to check for the presence of water. Any intrusion of water in the compartment containing the splices constitutes a failure. It is the responsibility of the Contractor to insure that the water immersion test has been performed by the manufacturer or an independent testing laboratory, and the appropriate documentation has been submitted to the Engineer.

657.03.5.2--OSP Closures for Buried Environments. OSP closures for buried applications will incorporate the following features.

Splice case must handle up to four cables. A butt adapter, if applicable could be used to increase capacity to eight cables.

Splice case shall be non-filled, non encapsulate to prevent water intrusion, and shall allow re-entry without any special tools. The closure shall be capable of preventing a 10-foot water head from intruding into the splice compartment for a period of seven days. Testing of the closure is to be accomplished by the placing of the closure into a pressure vessel and filling the vessel with tap water to cover the closure. Apply continuous pressure to the vessel to maintain a hydrostatic head equivalent to 10 feet on the closure and cable. This process shall be continued for seven days. Remove the closure, open to check for the presence of water. Any intrusion of water in the compartment containing the splices constitutes a failure. It is the responsibility of the Contractor to insure that the water immersion test has been performed by the manufacturer or an independent testing laboratory, and the appropriate documentation has been submitted to the Engineer.

The closure shall be capable of accommodating splice organizers which accept mechanical, single fiber fusion, or multi fiber splices. The closure shall have provisions for storing fiber splices and unspliced fiber/buffer tubes. The closure shall hold a minimum of two (2) splice trays to a maximum of 15 splice trays with each tray housing up to 24 splices. The closure shall be UL rated.

Closure re-entry and subsequent reassembly shall not require specialized tools or equipment.

For compression testing, the closure shall not deform more than 10% in its largest cross-sectional dimension when subjected to a uniformly distributed load of 396 lbf at 0°F and +100°F. The test shall be performed after stabilizing at the required temperature for a minimum of two hours. It shall consist of placing an assembled closure between two flat parallel surfaces, with the longest, closure dimension parallel to the surfaces. The weight shall be placed on the upper surface for minimum of 15 minutes. The measurement shall then be taken with

the weight in place. It is the responsibility of the Contractor to insure that the compressions test has been performed by the manufacturer or an independent testing laboratory, and the appropriate documentation has been submitted to the Engineer.

657.03.6--Fiber Optic Termination Hardware. For cross connect applications inside controller cabinets, the fiber optic cable shall be terminated using a 900- μ m fanout modular design for the fiber count being terminated. The non-metallic fan-out shall attach directly to the buffer tube and transition the 250- μ m coated fibers into the fan-out tubing. The fanout shall be housed in a wall mount distribution cabinet equipped with the appropriate number of adapters. The fibers shall be connected to the transmission equipment via ST/ST fiber optic patch cables. This hardware scheme shall also be utilized for wall mount applications.

For rack mount applications, the fiber optic cable shall be terminated using a 900- μ m fanout modular design for the fiber count being terminated. The non-metallic fan-out shall attach directly to the buffer tube and transition the 250- μ m coated fibers into the fan-out tubing. The fan-outs shall be housed in a fiber distribution center sized for 50% growth based on the initial installation. Appropriate panels for ST adapters shall be included based on the population of the fiber cable installed. If fusion or mechanical pigtail splicing is used for termination points, a splice housing with appropriate 900- μ m pigtails and splice trays shall be used in conjunction with the fiber distribution center.

657.03.7--Installation. All fiber optic components will be installed in accordance with the manufacturer's instructions. All necessary interconnections, services, and adjustments required for a complete and operable data transmission system shall be provided. All pole attachments, service loops, and conduit risers will be placed to minimize the possibility of damage as well as to facilitate future expansion or modernization.

Cable between controllers shall be lashed to a 1/4-inch EHS messenger with stainless steel lashing wire for aerial installations. The installation will be accomplished in accordance with accepted OSP construction practices. Precautions shall be taken to insure the installation specifications for the cable are not exceeded, i.e. tension, minimum bend radius. The cable shall be marked with an orange weatherproof identifying tag at each pole location, with print "Caution, Fiber Optic Cable".

The cable shall be installed in continuous runs as indicated on the plans. Splices shall be allowed only at drop points. Only those fibers necessary to complete the communication path shall be spliced, i.e. mid-span access. All other fibers in the cable(s) shall be left undisturbed; with a minimum of five feet of buffer tube coiled inside the closure.

Sufficient slack shall be left at each drop point to enable access of the cable components and splicing to occur on the ground typical two times the strand height plus 15 feet. For undergrade installations, the following minimum slack requirements shall apply: 50 feet at the pull box or controller location for mid-spans, 15 feet for point to point applications for each cable. For aerial slack storage at splice points, a radius controlling device, commonly referred to as a SNO-SHOE shall be used for securing resulting cable slack at aerial splice points and shall be mounted directly to the strand.

For aerial cable runs exceeding 6-pole spans between splice points as indicated on the plans, two opposing SNO-SHOES shall be placed on the span 50 feet apart to provide for a 100-foot service loop for future drops and for slack for repair and pole relocations.

Drop cable shall be routed to the controller cabinets via conduit risers as illustrated in the plans. The cable entrance shall be sealed to prevent water ingress.

The minimum requirement for fiber protection outside a fiber optic enclosure in ALL cases shall be 1/8-inch fanout tubing, containing a hollow 900- μ m tube, aramid strength members and an outer jacket, and shall be secured to the cable sheath.

The minimum requirement for fiber protection inside wall mount or rack mount fiber enclosure shall be 900 μ m buffering, intrinsic to the cable in the case of tight buffered fibers, or in the case of 250- μ m coated fibers, a fanout body and 900- μ m tubing secured to the buffer tube(s).

During installation, even if the tension specifications for the cable are not exceeded, the first ten feet shall be discarded.

Warning tape shall be placed 12 inches above the cable not to deviate ± 18 inches from the centerline of the optical cable. Warning tape shall be at least two inches wide and colored orange.

Permanent above-ground markers shall be placed at line-of-sight intervals. Each marker shall be visible from each adjacent marker but separated by no more than 1,000 feet.

657.03.8--Testing and Documentation.

657.03.8.1--OTDR Testing. Prior to the installation, the Contractor shall perform on-site on the reel testing. The Contractor is required to test all fibers in each reel of cable prior to installation. This testing is for both continuity and attenuation. The tests shall be conducted at 850 nm for multimode fibers and at 1310 nm for single mode fibers. The testing shall be performed using an Optical

Time Domain Reflectometer (OTDR) via a "pigtail" splice. The resultant OTDR trace(s) shall reflect overall length and attenuation expressed in db/km. All test results shall be within +3.0% of factory supplied attenuation measurements for multi-mode fibers and single mode fibers. Testing shall be done in one direction only. Hard copy or disk based with applicable software OTDR traces for the testing shall be supplied to the Engineer by the Contractor prior to installation of cables. The Contractor may opt to accept factory results and install cable at the Contractor's risk. In either case, On-the-reel test results shall be provided to the Engineer for each cable installed.

Following installation, each section of the installed cable shall be tested for continuity and attenuation as indicated above. The traces shall demonstrate that no change in transmission characteristics has occurred during installation and that any splices meet the requirements herein. This testing can be done in conjunction with the End-to-End testing described below. The traces shall be included in the documentation package provided at the conclusion of the contract.

657.03.8.2--Attenuation Testing. Only connectorized spans will be tested for final End-to-End attenuation or power loss. The testing shall be performed at 850 nm and 1300 nm for multimode and at 1300 nm for single-mode fibers. The testing shall be conducted using "hand-held" optical test sets and shall be conducted using a two jumper reference. The testing shall be in one direction only. The results shall be tabulated and be include in the documentation package provided at the conclusion of the contract. Overall loss for each link shall not exceed the cumulative specified losses of the components in the link. EXAMPLE: At 850 nm, a 1-km link with two splices and a connector on each end shall not exceed 5.0 dB ((3.5dB + 0.25dB + 0.25dB + 0.5dB +0.5dB))

At the conclusion of the contract, two copies of system documentation package shall be provided. It shall include at a minimum:

- Post installation OTDR traces for each fiber.

- End-to-End Attenuation measurement for each fiber.

- A splice plan showing the location and configuration of any splices in the system as well as how the transmission scheme is set up.

- Reference manuals for equipment provided.

657.03.9--Training and Equipment. After the installation is complete the Contractor shall provide formal classroom training and "hands-on" operations training for proper operation and maintenance of the fiber optic plant. The training shall be conducted by a trainer with a minimum of four years of experience in training personnel on the operation and maintenance of fiber optic systems. The training shall be provided for up to six personnel designated by the Engineer and shall be a minimum of one day in duration. All training materials shall be provided by the Contractor.

657.04--Method of Measurement. Fiber optic cable of the type specified will be measured by the linear foot, measured horizontally along the conduit or aerially along the messenger cable. No differentiation will be made for cable installed underground or aerially.

Fiber optic drop cable and video drop cable will be measured by the linear foot from the trunk line to the controller cabinet.

All required cabinet facilities shall not be measured for separate payment. All standard or special fiber optic modems, fan out boxes, splicing devices, warning tape, above ground markers, backplane facilities, twisted pair communications cable interface devices, etc., and any other cabinet modifications required for the fiber optic system shall be included in the price bid for other items of work.

657.05--Basis of Payment. Fiber optic and drop cable, measured as prescribed above, will be paid for at the contract unit price bid per linear foot, which price shall be full compensation for furnishing all materials, for all installing, connecting, cutting, pulling and testing and for all equipment, tools, labor and incidentals necessary to complete the work.

Payment will be made under:

- 657-A: Fiber Optic Cable, No. of fibers, No. / mode - per linear foot
- 657-B: Fiber Optic Drop Cable, No. / mode - per linear foot
- 657-C: Fiber Optic Video Drop Cable, No. / mode - per linear foot

SECTION 661 – MULTI-CHANNEL VIDEO MULTIPLEXER

661.01--Description. The multi-channel video multiplexer series shall utilize the latest state-of-the-art digital encoding and decoding for high quality video transmission and shall exceed the requirements of EIA RS-250C for medium-haul video transmission. The units shall provide transmission of up to 16-independent video channels over one multimode or single mode optical fiber and shall be able to use in unconditioned roadside or out-of-plant installations. The units shall be universally compatible with any CCTV camera system. Plug-and-play design features with LED indicators are required.

661.02--Materials. Multi-channel video multiplexer shall meet the requirement of Subsection 722.22.

661.03--Construction Requirements. The installation of each multiplexer unit shall consist of mounting in a cabinet and connecting to input and output cables as indicated on the plans or as directed and shall present a neat and workman like

appearance. The Contractor shall demonstrate to MDOT's satisfaction the operation of the multiplexer's video inputs and outputs.

661.04--Method of Measurement. Multi-channel video multiplexer of the type specified will be measured as a unit per each, which shall include cabinet, all wiring, hardware, other equipment and incidentals necessary to complete the work.

661.05--Basis of Payment. Multi-channel video multiplexer, measured as prescribed above, will be paid for at the contract unit price per each, which price shall be full compensation for furnishing all materials, construction installing; connecting, testing, and for all equipment, tools, labor and incidentals required to complete the work.

Payment will be made under:

661-A: ____ Channel Video Multiplexer - per each

SECTION 666 - ELECTRIC CABLE

666.01--Description. This work consists of furnishing, erecting, installing and/or laying electric cable "mains" in conformity with these specifications and true to locations, line and grades as shown on the plans or as directed. It shall include excavating, laying, placing tracer cable or tape, backfilling, replacing sod, aerial supports and/or pull-through conduits, as applicable; and terminal boxes when not placed under other items of the contract.

666.02--Materials. The materials used in this construction shall be of the type and size indicated on the plans and shall conform to the applicable requirements of Subsection 722.03.

666.03--Construction Requirements.

666.03.1--General. Except where indicated on the plans or approved by the Engineer, cables shall be spliced only in pole bases or controller cabinets. At each splice, sufficient slack shall be left in the cable for resplicing. The greatest care shall be exercised in handling all cable to avoid damage to the conductor and its coverings. No sharp bends shall be permitted to form; reels shall not be dropped; and cable with discernable damage in any part shall be rejected. Cable shall be handled and installed only by experienced personnel. All connections shall be made with approved terminal blocks meeting the requirements of Subsection 722.08.

666.03.2--Direct Buried Cable. Trenches shall be excavated by hand or mechanical methods to the depth and width indicated on the plans, or as directed.

The cable shall be laid on a six inch cushion as shown on the plans or as directed and covered with a similar layer. The electric cable shall be "snaked" laid in the trench. The earth backfill then shall be placed in layers of eight inches or less, and each layer compacted by approved methods to the density of adjacent ground. Cable placed under traveled roadways shall be pulled through previously placed metal conduit, and such pulling shall be incidental to work.

The ground surface backfilled trenches shall be neatly dressed, all soil shall be removed from the right-of-way, and the sod shall be replaced over the finished trench, all as directed.

666.03.3--Support of Aerial Conductor Cable. Aerial conductor cable normally shall be supported by messenger cable affixed by approved devices to supporting structures. In all cases the cost of messenger cable and other support devices will be included in the contract unit price bid for electric cable.

666.03.4--Cable and Conduit. Cable lengths required shall be obtained by accurate measurement of the runs with liberal allowances made for slack in boxes, slack for terminating and waste due to wire-grip damage. Open ends of cables shall be rubber taped at all times to avoid penetration of water or moisture into the strands of the cable. Pull-in guides, cable feeders or drawing-in protectors shall be employed to prevent damage to the cable at the duct mouth. An individual pull-in grip shall be used on each single conductor in the cable core to provide equal strain on each conductor. Cable whose jacket insulation or conductors have been damaged or displaced by pull-in grip shall be cut off and discarded before terminating. Cable shall be fed manually into the pull-in guide, cable feeder, or protector in such manner as to avoid excessive friction on the cable. Pulling shall be instantly stopped if undue tension occurs. Powdered talc, water or other lubricant, approved by the cable manufacturer, shall be used to facilitate pulling in runs over 200 feet, and may be used if desired on shorter runs. In no case shall grease be used as cable lubricant.

666.03.5--Identifying and Tagging. Individual phases of each signal circuit shall be identified by appropriate identifying marks, at points near each end of the cables and in each handhole or pull box.

Before connections are made at cable terminals, these marks shall be checked by talking over each conductor by means of a portable hand telephone set. Circuits shall also be identified in similar manner before terminal connections are made.

All cable entering controller cabinets, pull boxes and poles shall be identified with permanent labels or tags indicating the function of each conductor and which pole, pull box, or controller it goes to.

When required in the plans, the installation of tracer cable shall be in accordance with the requirements herein, per the manufacturer's recommendation, or as

directed by the Engineer. When tracer cable is installed in an open trench, a non-detectable warning tape will be placed directly over the buried cable, four to six inches below finished grade.

666.03.6--Backfilling. Granular material for backfilling buried cable trenches shall be as shown on the plans.

666.03.7--Field Tests. The cable shall be tested for failure in accordance with Subsection 634.03.2. The test shall be made after cable has been installed and before connections have been made.

666.03.8--Interpreting the Test. If a cable fails, the fault shall be located and the cable replaced between terminal points. If failure occurs in conduit, all cables in that conduit between the nearest pulling points on each side of the failure shall be withdrawn. If, in the opinion of the Engineer, the other cables in the same conduit have not been damaged, they may be reinstalled, but the cable which failed shall be replaced with new cable. After replacement of the faulty cable, and any damaged cables, all cables of that circuit shall be retested.

666.04--Method of Measurement. Electric cable of the type specified, constructed as specified on the plans, will be measured by the linear foot. Measurement will be computed horizontally along the conduit or messenger cable which the electric cable is placed, from center to center of the several installations comprising the circuits. No extra length will be allowed for vertical measure of any kind; for cable inside signal heads; or for sag in aerial supported cable. Tracer tape used with tracer cable will not be measured for separate payment but shall be included in the contract price for tracer cable. The terminals for the measurements of lengths will be considered specifically as the center of the pull boxes, poles, signal heads or controller cabinets.

Excavation, sod and backfill will not be measured for separate payment but shall be included in the cost of other items bid.

Messenger cable and other supporting devices for aerial electric cable will not be measured for separate payment, but shall be included in the cost of other items bid.

666.05--Basis of Payment. Electric Cable of the type specified, measured as prescribed above, will be paid for at the respective contract unit price per linear foot, which price shall be full compensation for furnishing, installing, connecting and testing all materials; for pulling through conduit and poles; for attaching to messenger cable; for final cleanup; and for all labor, equipment, tools, and incidentals necessary to complete the work.

Payment will be made under:

- 666-A: Electric Cable, Direct Burial, Type, AWG __, ___ Conductor - per linear foot
- 666-B: Electric Cable, Underground in Conduit, Type, AWG __, ___ Conductor - per linear foot
- 666-C: Electric Cable, Aerial Supported, Type, AWG __, ___ Conductor - per linear foot
- 666-D: Electric Cable, Aerial Supported in Conduit, Type, AWG __, ___ Conductor - per linear foot
- 666-E: Electric Cable, Underground in Conduit, Tracer Cable - per linear foot

SECTION 667 - UNDERGROUND ELECTRIC CABLE - REMOVED AND RELAID

667.01--Description. This work consists of excavating by hand method existing electric cable, and where present from its existing location and relaying electric cable "Mains" in reasonably close conformity with these specifications, and the locations, lines, grades as shown on the plans or directed. It shall include excavating new cable trench, relaying cable; backfilling, replacing sod, pulling through conduits as applicable; and furnishing terminal boxes, if required and not required under other items of the contract.

667.02--Material Requirements. Material for backfilling cable trenches shall be as shown on the plans.

667.03--Construction Requirements.

667.03.1--Excavating Existing Cable. Existing cable, and its protective covering, if indicated on the plans, shall be removed by hand trenching, exercising extreme care to prevent damage to cable in trenching and relaying in the new trench. After cable has been removed from existing location, the trench shall be backfilled and compacted to the density of adjacent soil.

667.03.2--Field Test for Cable Failure. Field test for cable failure shall be as specified in Subsections 666.03.7 and 666.03.8.

667.04--Method of Measurement. Underground electric cable, removed and relaid, will be measured as provided in Subsection 666.04.

Excavation, sod and backfill will not be measured for separate payment but shall be included in the contract unit price per linear foot for electric cable-removed and relaid.

667.05--Basis of Payment. Underground electric cable, removed and relaid, measured as prescribed above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for excavation, removing existing cable and its protective covering; for excavating new trench; for laying cable as indicated on the plans; for backfilling old trench; for backfilling new trenches with selected sand, sand clay or clay gravel as indicated on the plans; for replacement of sod; for final cleaning up; and for all labor, equipment, tools, testing, and incidentals necessary to complete the work.

Payment will be made under:

667-A: Underground Electric Cable, Removed and Relaid - per linear foot

SECTION 668 - TRAFFIC SIGNAL CONDUIT

668.01--Description. This work consists of furnishing conduit of specified materials and dimensions and installing them in accordance with these specifications and the details shown on the plans, or directed. It shall include the furnishing and installing of pull boxes, expansion joints, connections, and other items incidental to the completed work.

668.02--Materials.

668.02.1--General. The materials used in this construction shall be of the type and size as indicated on the plans and shall meet the requirements indicated herein below.

668.02.2--Conduit. Conduit shall meet the requirements of Subsection 722.05.

668.02.3--Pull Boxes. Pull boxes shall be in accordance with the requirements of Subsection 722.06.

668.02.4--Expansion Joints. Expansion joints shall meet the requirements of Subsection 722.10.

668.02.5--Miscellaneous Hardware. Miscellaneous hardware shall meet the requirements of Subsection 722.11.

668.02.6--Other Miscellaneous Materials. Other miscellaneous materials shall meet the requirements of the appropriate Subsection(s) of Section 722.

668.02.7--Granular Materials. Granular materials for filling dry wells shall meet the requirements of Subsection 704.02.

668.02.8--Concrete. Concrete for encasement shall be Class B Concrete,

meeting the requirements of Section 804.

668.03--Construction Requirements.

668.03.1--General. The following general requirements are applicable to all types of installation:

- (a) Where pull boxes are installed adjacent to poles, conduit between pull box and pole shall not be less than one and one-half inch size.
- (b) It shall be the privilege of the Contractor, at no additional cost to the State, to use larger size conduit if desired, and where larger size conduit is used, it shall be for the entire length of run from terminal to terminal. No reducing couplings will be permitted.
- (c) All conduits entering any and all concrete foundations, etc., shall have an approved weatherproof type of threaded union coupling or fitting outside concrete for future maintenance needs.
- (d) All conduit ends shall be capped with standard conduit caps until wiring is started. When caps are removed from rigid metal conduit, the ends shall be provided with approved conduit grounding bushings.
- (e) The location of all conduit placed for future electrical circuits shall be marked by a symbol at least three inches high cut into the pavement, face of curb, gutter or wall, directly above the conduit.
- (f) Conduit bends, except factory bends shall have a radius of not less than six times the inside diameter of the conduit. Where factory bends are not used conduit shall be bent, without crimping or flattening, using the longest radius practicable.
- (g) Conduit runs shall not exceed 420 feet in length unless otherwise indicated on the plans.
- (h) Conduit runs shown on the plans are for bidding purposes only, and may be changed with permission of the Engineer to avoid underground obstructions. A change order may be authorized if conduit runs can be made on opposite side of street to that shown on plans, in order to avoid obstructions and inconvenience to traffic. Final location of conduit shall be shown on the final as-built plans.

668.03.2--Underground Traffic Signal Conduits. The following requirements are applicable to underground installations:

- (a) Rigid metal conduit stubs, caps and exposed threads, as well as any point along the surface of the conduit that may have been injured in handling or installation, shall be painted with a good quality of asphalt, bituminous, or other paint suitable for the purpose. Where conduit is laid in cinders or gravel, it shall be enclosed in a two-inch jacket of concrete.
- (b) Conduit shall be laid to a depth of not less than 18 inches below the curb or curb and gutter grade in the sidewalk areas, and to a depth of not less than 30 inches below the finished grade in all other areas, except under

railroad tracks where it shall be not less than 36 inches below bottom of tie.

- (c) All pull boxes and splice boxes shall have drainage facilities provided in them.
- (d) Rigid metal conduit shall be placed under existing pavement by approved jacking or drilling methods. Pavement shall not be disturbed. Jacking and drilling pits shall be kept two feet clear of the edge of any type of pavement wherever possible. Excessive use of water that may cause undermining of the pavement will not be permitted. Excavation and backfill incidental to the operation will not be paid for separately.
- (e) Conduit terminating in pole or pedestal bases shall extend approximately two inches above the foundation vertically, or shall be sloped toward the handhole opening. Conduit entering through the bottom of a pull box shall be located as near the sides and ends as possible to leave the major portion of the box clear. Conduits shall ride freely through boxes for allowance of expansion and contraction.
- (f) Where it is deemed inadvisable to install expansion fittings in closely confined areas, the Engineer may permit the installation of approved bronze flexible tubing instead; expansion joints and tubing shall be the same size as the conduit.
- (g) Conduit entering controller cabinets shall be sealed to prevent the entrance of gases, using paraffin or other approved sealing compound as directed by the Engineer.
- (h) Before placing electric cable in existing rigid metal or rigid nonmetal conduit the conduit shall be cleaned with compressed air and rigid metal conduit shall also be cleaned with a mandrel.
- (i) Roll pipe conduit shall be installed in accordance with the requirements set forth herein, as per the manufacture's recommendations, or as directed by the Engineer.

668.03.3--Installation. Types III and IV

668.03.3.1--Trimming. All cut ends shall be trimmed inside and outside to remove rough edges.

668.03.3.2--Joints. All joints between lengths of conduit, couplings, fittings and boxes shall be made by a method specifically approved for the type conduit being used.

668.03.3.3--Supports. Rigid nonmetallic conduit when installed above ground shall be adequately supported as required in Table II. In addition, there shall be a support within four feet of each box, cabinet, or other conduit termination.

TABLE II
SUPPORT OF RIGID NONMETALLIC CONDUIT

Conduit Size, Inches	Maximum Spacing Between Supports, Feet	
	Conductors Rated 60°C and Below	Conductors Rated More than 60°C
½ - ¾	4	2
1 - 2	5	2½
2½ - 3	6	3
3½ - 5	7	3½
6	8	4

668.03.3.4--Expansion Joints. Expansion joints shall be provided where required to compensate for thermal expansion and contraction.

668.03.3.5--Bends. Bends shall be made so that the conduit will not be injured nor shall the internal diameter of the conduit be reduced. Field bends shall be made only with bending equipment specifically intended for the purpose being used.

668.03.3.6--Use Permitted. Type III and IV Polyvinyl Chloride (PVC) Conduit may be used under ground or above ground.

Type III shall be for encasement burial in concrete and Type IV shall be for direct burial with or without encasement.

668.03.4--Aerially Supported Traffic Signal Conduits. The following requirements are applicable to aerially supported installations:

- (a) Conduit entering pull boxes shall terminate two inches inside of the box wall and not less than two inches above the bottom. Conduit entering through the bottom of a pull box shall be located as near the sides and ends as possible to leave the major portion of the box clear. Conduits shall ride freely through boxes for allowance of expansion and contraction.
- (b) Expansion fittings as detailed on bridge structure plans shall be installed where conduit crosses an expansion joint in the structure. Where it is deemed inadvisable to install expansion fittings in closely confined areas, the Engineer may permit the installation of approved bronze flexible tubing instead; expansion joints and tubing shall be the same size as the conduit.
- (c) All assemblies on concrete structures shall be grounded through a bonding jumper to the rigid metal lighting conduit, which in turn shall be bonded to the steel superstructure or run to the ground.
- (d) All conduit, junction boxes, pull boxes, etc., must be attached to bridge

structures by means of studs driven by approved methods.

- (e) Aerial conduit shall be supported by messenger cable suspended from approved supporting devices when shown on the plans or directed.

668.03.5--Testing Conduit. After the completion of concrete work on fiber-lined concrete ducts, and before any cable is drawn into these ducts, each duct shall be tested with a round test mandrel of a size especially manufactured for the size of duct being tested. The mandrel shall be of the rigid type not less than 12 inches in length, and shall have tool steel cutting ends to remove concrete and other obstructions from the ducts. In conduit runs consisting of fiber-lined concrete duct and steel conduit combined, when it is impracticable to test with a rigid mandrel, tests shall be made with a flexible mandrel consisting of tool- steel discs mounted on a flexible wire rope. In all cases, ducts shall be thoroughly cleaned of water, sand and silt by drawing properly sized cylindrical brush through each duct as many times as necessary.

668.04--Method of Measurement. Traffic signal conduit of the type specified will be measured by the linear foot computed horizontally along the signal conduit, such measurement being made from the point of beginning to the point of termination of all sections of conduit, in trench, under roadways, or supported on structures. No extra length will be allowed for risers to controller cabinets, pole handholes, or pull boxes.

Jacking, drilling, excavating, backfilling and replacement of sod will not be measured for separate payment, but shall be incidental to and included in the contract unit prices for Direct Burial and Jacked or Drilled underground installations as applicable.

Messenger cable and other supporting devices for aerial supported signal conduit will not be measured for separate payment but shall be incidental to and included in the contract unit price for traffic signal conduit, aerial supported.

668.05--Basis of Payment. Traffic signal conduit, measured as prescribed above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for furnishing, laying, placing, forming, curing, connecting, supporting aerially, cleaning and testing all conduit, pull boxes, junction boxes not specified on plans or ordered, and incidental materials; for all excavating, backfilling, drilling and/or jacking necessary for subsurface installations; for replacing sod; encasement in concrete; final cleaning up; and for all labor, equipment, tools and incidentals necessary to complete the work.

Payment will be made under:

668-A: Traffic Signal Conduit, Underground, Type, Size - per linear foot

668-B: Traffic Signal Conduit, Underground Drilled or Jacked,
Type, Size - per linear foot

668-C: Traffic Signal Conduit, Aerial Supported, Type, Size - per linear foot

668-D: Traffic Signal Conduit, Underground Encased in
 Concrete, Type, Size - per linear foot

SECTION 680 -- PORTABLE CONSTRUCTION LIGHTING

680.01--Description. Whenever the Contractor's operations are being conducted at night, the Contractor shall provide artificial lighting as may be necessary to provide for safe and proper construction and inspection of the work.

680.02--Materials. All lighting equipment will be furnished as required and retained by the Contractor after the work is completed. Material and/or equipment are not required to be new but shall be in good operating condition and in compliance with applicable safety and design codes.

The Contractor shall submit, for the Engineer's review and approval, a lighting plan showing the type and location of lights proposed for use during night work. The lighting plan shall be presented on standard size roadway plan sheets, 22" x 36", and on a scale of either fifty (50) feet or 100 feet to the inch. It shall clearly show the location of all lights necessary for every aspect of work to be done at night. In addition to the plan sheets, the Contractor shall submit catalog cuts giving the specific brand names, model numbers and ratings of the lighting equipment. The submittals shall include power ratings and photometric data. The Contractor shall allow fourteen (14) days for the Engineer to review the submittals. Night work shall not begin without the Engineer's approval of a lighting plan and the indicated lighting equipment and/or materials being in operation.

The Contractor may be required to take lighting level measurements in the presence of the Engineer at locations designated by the Engineer to verify compliance with the approved lighting layout submittals. Field light level measurements shall be equal to or exceed light levels on the submittal.

680.02.1--Tower Lights. A tower light shall consist of mercury vapor, metal halide or high pressure sodium fixtures mounted on a tower approximately thirty (30) feet in height. The tower light fixtures shall be heavy duty flood, area, or roadway style with wide beam spread. The tower shall be sturdy and free-standing without the aid of guy wires or bracing. The power supply shall be of sufficient capacity to operate the light(s) and shall be located for the shortest safe routing of cables to the fixtures.

Tower lights shall be of sufficient wattage and/or quantity to provide an average maintained horizontal luminance in accordance with the work to be done. See Subsection 680.02.3 for recommended light levels.

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.

680.02.2--Machine Lights. All moving equipment used during night time operations shall have a mounted lighting system and flashing amber light on the equipment. In lieu of a flashing amber light, the Contractor may install four square feet of approved reflective material on the equipment in a location that will be seen by the traveling public. This lighting system shall illuminate the work area in each direction of travel of the equipment. Machine lights shall be 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 thirteen (13) feet. The power supply shall be of sufficient capacity to operate the light(s) and shall be securely mounted on the machine. Electrical grounding of generators to frames of machines on which they are mounted shall be done in conformance with the National Electrical Code (NEC).

The machine light fixtures shall be of sufficient wattage and/or quantity to provide an average maintained horizontal luminance in accordance with the work to be done. See Subsection 680.02.3 for recommended light levels. Machine lights are in addition to conventional automotive type head lights which are necessary for maneuverability.

To avoid distraction to motorists, do not operate the flashing lights on equipment working outside the clear zone or behind traffic control devices.

680.02.3--Lighting Levels. The lighting plan submitted shall indicate how the Contractor intends to accomplish the lighting of the work area(s). Work areas shall be classified into one (1) of the following categories depending on the type of work to be accomplished:

CATEGORY I - Category I work areas will be lit to five foot-candles (5 fc). This category of work includes general work zone safety and visual tasks with large objects.

CATEGORY II - Category II work areas will be lit to ten foot-candles (10 fc). This category of work includes work around all construction equipment and visual tasks that require greater accuracy such as inspection of paving and resurfacing activities.

CATEGORY III - Category III work areas will be lit to twenty foot-candles (20

fc). This category of work includes activities that require the highest visual efficiency. These tasks present higher levels of visual difficulty and require significant attention from the observer, such as crack and pothole filling, joint sealing, critical connection and maintenance involving electrical connections and moving mechanical parts.

Lighting equipment shall be placed so the uniformity ratio, average maintained to minimum, shall not be greater than 10:1.

680.03--Construction Requirements. Tower lights may be used when the night work is confined to a fairly small area and is essentially a stationary operation.

Machine lights may be used 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.

The work area where traffic control devices are being set up or repositioned at night shall be illuminated.

The illuminated work area shall be large enough so that the movements of all personnel and equipment engaged in the work will be contained in the area.

The Contractor shall 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 roadway lights shall 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, if noted in the Contractor's submitted lighting plan.

680.04--Method of Measurement. Portable construction lighting, by tower and/or machine lighting systems, will be measured for payment only when a pay item for portable construction lighting is included in the contract. Otherwise, portable construction lighting will be considered incidental to other contract items and no direct payment will be made.

When payment for the portable construction lighting is provided in the contract, measurement will be made at the contract lump sum price. Partial payments for this pay item will be made as follows:

1. 50% of the lump sum price on the first monthly estimate after using the

lighting system.

2. 25% of the lump sum price on the first monthly estimate made after the project is 50% complete.
3. 25% of the lump sum price on the first monthly estimate after the completion of all scheduled night work.

680.05--Basis of Payment. Portable Construction Lighting, as measured above, shall be paid for at the contract lump sum price, which price shall be full compensation for furnishing, operating and maintaining everything necessary to provide a portable construction lighting system.

Payment will be made under:

680-A: Portable Construction Lighting

- lump sum

SECTION 681 - ROADWAY LIGHTING SYSTEM

681.01--Description. This work consists of furnishing; installing, testing, erecting, constructing and assembling all materials to insure a properly operating roadway lighting system in accordance with the plans and specifications.

681.02--General Provisions.

681.02.1--Tests and Inspection. The complete job shall be, during and/or after construction, subject to the supervision of the Engineer. Inspections and tests shall be conducted by the Engineer or in the presence of the Engineer prior to acceptance of the project and shall consist of the following tests:

- (1) Upon written notice, the Contractor shall furnish two men, one to include the job foreman, and tools to assist and be directed by the Engineer for a period of time required to make such tests and inspections as are requested by the Engineer pertaining to the safety and operation of any devices or system installed.
- (2) Insulation break-down tests with a megaohm meter shall be conducted on each and every circuit. Results of the tests shall meet minimum requirements for such tests set up by the latest edition of U.L. Standard 83. All readings shall be made in the Engineer's presence and a written report of same submitted to the Engineer upon completion of these tests.
- (3) The ground resistance of each ground rod and grounding system shall be measured. The resistance and soil conditions at the time the measurements were made shall be recorded and a report shall be submitted to the Engineer for approval. Ground-resistance measurements shall be made in normally dry weather, not less than forty-eight (48) hours after rainfall, and with the ground under test isolated from other grounds. Ground resistance shall also be measured from each

piece of equipment to the ground electrode. The ground rods and grounding system shall meet the requirements of the National Electrical Code (NEC). The Contractor shall be required to correct any deficiencies prior to acceptance of the system.

- (4) The Contractor shall be required to demonstrate in the presence of the Engineer, the operation of each and every device installed. This shall include, but not be limited to, all winches, latching devices, photocells and circuit breakers.
- (5) The Contractor may be required to take lighting level measurements in the presence of the Engineer at locations designated by the Engineer to verify compliance with the approved lighting layout submittals. Field light level measurements shall be equal to or exceed light levels on the submittal.

After completion of all tests, the Contractor shall request a semi-final electrical inspection. After this inspection and when all discrepancies have been corrected, the roadway lighting system shall be placed in operation for a satisfactory performance period. Final electrical inspection will not be made until the entire roadway lighting system has operated satisfactorily for a period of not less than fourteen (14) consecutive days, during which period(s) contract time will continue to be evaluated. During each fourteen (14) day performance period, if any failure should occur in any of the mechanical or electrical equipment in the system other than minor readily replaceable components, such as light bulbs, etc., the cause of the failure shall be determined, the necessary replacements made and the system operated satisfactorily for an additional period of not less than fourteen (14) consecutive days.

Upon completion of all work on the project and the satisfactory completion of the fourteen (14) day performance period on the roadway lighting system, the Contractor may request a final inspection of the project. If all items of work, excepting the completion of the Contractor's warranty period on the roadway lighting system, are considered satisfactory and acceptable, the Contractor may be given a partial maintenance release. This partial maintenance release is to relieve the Contractor of responsibility, except as stated in the roadway lighting system material warranty section, from maintenance on all other items of work on the project during the warranty period on the roadway lighting system. If the minimum 6-month warranty period has expired on the day of final inspection, this partial maintenance release is to relieve the Contractor of responsibility from maintenance on all items of work on the project.

During final inspection or upon completion of the warranty period after the final inspection, the Contractor shall request an inspection of the roadway lighting system. If this work is considered satisfactory and acceptable, the Contractor may be given a full maintenance release.

Payment of the final estimate releasing the remaining retainage will not be made

until after final acceptance of the project.

No additional time will be allowed for any additional performance period(s) found to be necessary because of failure(s) during the initial period, or subsequent performance period(s).

Acceptance will be for the entire roadway lighting system, no parts of the system will be accepted separately.

681.02.2--Material Warranty. The following Contractor warranty stipulations are in addition to those covered by Subsection 106.01.2 of the Standard Specifications.

All roadway lighting equipment and related components shall be fully operational at the final inspection of the project.

The Contractor shall warrant and guarantee all roadway lighting equipment and related components for a minimum period of six (6) months. This warranty period may begin after the day of partial release from maintenance or at the start of continuous use as referenced in Subsection 681.02.8. Regardless of when the warranty period begins, the Contractor shall warrant and guarantee the roadway lighting equipment and related components (1) at least up to and including the day of final inspection and (2) during the Contractor's warranty period. Final acceptance will not be made until after the warranty period expires.

It is the intent of the preceding paragraph to provide for equipment which performs as intended by the manufacturer. It is the further intent to obtain from the Contractor a level of workmanship which will assure the Department of an operational system devoid of Contractor laxities. Failure to perform as indicated shall require the Contractor to replace in kind or repair, the equipment or workmanship in question at no additional cost to the State. All materials and labor cost resulting from the replacement or repair of equipment or correction of poor workmanship shall be borne by the Contractor.

The Contractor shall not be responsible for outages occurring during the warranty period due to vandalism, traffic accidents or any problem not related to materials or workmanship. The Contractor will be required to make the necessary repairs but the cost of such repair shall be borne by the Department.

All manufacturer's standard warranties or guarantees on all electrical and mechanical equipment which are provided as customary trade practice shall be delivered to the Engineer at the final inspection. All warranties and guarantees shall be made out to the MDOT.

681.02.3--General Information. Plans are diagrammatic and care shall be exercised to install all electrical work in a manner which shall function in

accordance with plans, specifications and manufacturer's recommendations.

Exact location of all equipment shall be determined from dimensions on the plans, manufacturer's shop plans, or as directed by the Engineer.

Conduit runs, cable runs and circuit groupings are indicated diagrammatically with number of conductors shown in each run to clarify the operation and function of the system. The Contractor shall provide the number of conductors and conduits to produce an operative system as specified herein.

All materials shall be new and of equal or superior quality to those specified. All equipment or materials shall conform to the latest requirements and/or additions to the Underwriter's Laboratories, National Electrical Code, or National, State or local agency having jurisdiction.

All materials, devices, equipment, etc. shall be installed, tested, and connected in strict compliance with the manufacturer's recommendations, and, where specified, under the direct supervision of a manufacturer's representative.

All materials, devices, equipment, lighting, etc. shall be installed as required by the plans, specifications and manufacturer's recommendations. The Contractor shall use only experienced labor to do all trenching and jacking.

All equipment and apparatus furnished shall be protected from damage by the Contractor. All items marred or damaged shall be replaced or repaired to the complete satisfaction of the Engineer solely at no additional cost to the State.

Any piece of equipment, switch, device, etc. shown to be mounted on and/or adjacent to any existing equipment, which if installed may impair the proper operation of that equipment, shall be moved by the Contractor as required in order that existing equipment shall function properly. The Engineer shall be notified if any such condition exists.

It shall be the responsibility of the Contractor to provide training in the operation and maintenance of all parts of the roadway lighting system to any person, or persons designated by the Engineer. The training shall consist of a minimum of eight (8) hours of on-site instructions and shall be conducted near the end of completion of all work, but prior to final acceptance of the project.

The Contractor shall furnish the Engineer three (3) bound sets of the manufacturer's publications relating to the installation, operation and maintenance of all component parts of the roadway lighting system. The Contractor shall maintain a complete and accurate set of as-built plans throughout the project. At the final inspection, one (1) set each of full scale and 1/2 scale as-built blueprints shall be furnished to the Engineer.

The Contractor shall submit eight (8) copies of a letter of certification from the high mast manufacturer on manufacturer's letterhead, certifying that all of the lowering devices, poles and luminaires have been installed in accordance with the manufacturer's guidelines.

As referenced in Section 683 regarding high mast lighting assemblies, the following shall be provided from the same manufacturer.

- (1) Poles
- (2) Lowering Devices
- (3) Luminaires
- (4) Anchor Bolts
- (5) Portable Power Unit

The Contractor will be responsible for all power costs including deposits, customer charges, connection cost, etc. associated with roadway lighting system. The Contractor shall provide all electrical power required for construction, tests, satisfactory performance period(s), and usage up to and including the day of the final inspection of the system. Beginning on the day after the final inspection all power and related cost will be paid by the Mississippi Department of Transportation. The Department may assume power cost prior to the final inspection if the requirements of Subsection 681.02.8 are met.

All lamps shall be from the same manufacturer.

681.02.4--Corrosion Protection. It is the intent of these specifications to have all joints, connections, etc. completely water and moisture tight.

681.02.5--Coordination of Existing Utilities. It shall be the responsibility of the Contractor to coordinate work near all existing utilities, both overhead and underground, and to verify utility locations with the various utilities companies prior to commencing any work. Failure to do this shall not relieve the Contractor of any responsibility and will not be justification for requesting additional money from the MDOT due to damage of any of these utility lines.

681.02.6--Removal of Salvaged Material and Debris. It shall be the responsibility of the Contractor to have all salvaged materials, debris, etc. resulting from the Contractor's operations completely removed from the project site continually during construction.

681.02.7--Initial Power Cost. The Contractor will make all application and contacts necessary to obtain power from the local utility company. All cost relating to obtaining, providing, using of electrical power during the entire life of the contract will be absorbed by the Contractor, with exception noted in Subsection 681.02.8.

681.02.8--Operation of the System. After the final electrical inspection is completed and all noted deficiencies have been corrected, the system may be placed in operation at the request of the Engineer. This shall be accomplished before the complete removal of any temporary lighting system. When the system is placed into operation at the request of the Engineer, the Department will begin assuming all power costs. The Contractor will submit to the Department, original bill(s) received from the Utility Company after the day the Department assumed the power cost. The Department will pay for only the cost of power used during and after that billing period.

The Contractor will continue to warrant and maintain the system up to and including the day of final inspection.

The date the system is placed in operation at the request of the Engineer, shall be considered the commencement of the warranty period, otherwise material warranties will be in accordance with Subsection 681.02.2.

681.03--Codes and Standards. The Contractor shall strictly comply with the latest edition of the National Electrical Code, Federal, State or local codes having jurisdiction and shall notify the Engineer of any conflict between any of these codes and the plans and/or specifications before bid date or correct same at no additional cost to the State.

The following Codes shall be complied with in each and every respect as though fully written herein:

- (1) Latest Edition - National Electrical Code
- (2) Latest Edition - National Electrical Safety Code
- (3) AASHTO Requirements, Latest Edition, thereof

681.04.2--Basic Materials and Methods. The Contractor shall submit to the Engineer eight (8) copies of submittal data for all electrical materials and equipment proposed for use not later than twenty (20) days after the date of the Notice to Proceed and prior to beginning any work.

Refer to Subsection 105.01 of the Standard Specifications for explanation of the Engineer's authority with respect to materials furnished.

Before purchasing any equipment, the following materials shall be submitted to the Engineer for approval: Eight (8) copies of shop plans, computerized lighting layouts, test reports, and design calculations, showing overall dimensions, bus sizes, bussing diagrams, lug sizes, equipment rating, lighting levels on the roadway and all other pertinent information for the following items:

- (1) Lighting Controller
- (2) Wire and Cable

- (3) Conduit, Fittings and Pull Boxes
- (4) Luminaires
- (5) Wiring devices
- (6) Lamps
- (7) Poles
- (8) Lowering devices
- (9) Portable electric power unit
- (10) Breakaway bases
- (11) Ground Rods
- (12) Safety Switches
- (13) Hardware
- (14) Miscellaneous items as shown on the plans and/or stated herein

The Contractor shall provide manufacturer's in-use history data on the following items:

- (1) Luminaires
- (2) Poles
- (3) Lowering devices
- (4) Lowering devices - power unit

Shop plans for poles and breakaway devices shall include conformance certification that the device meets or exceeds the latest AASHTO standards. Information must also include all bolt torque requirements for anchor bolts and breakaway device bolts.

This data shall include a minimum of two (2) recently completed installations, a minimum of five (5) installations that have been in-place five (5) or more years; also, provide the name and address of the owner of each installation. The data shall be submitted with shop plans.

Reinforcing steel shall comply with Section 711 of the Standard Specifications.

Concrete shall comply with Section 804 of the Standard Specifications.

SECTION 682 - ELECTRICAL DISTRIBUTION SYSTEM

682.01--Description. In addition to the requirements set forth in Section 681, the electrical distribution system generally will consist of the secondary electrical service, grounding and bonding system, secondary distribution and secondary power controller.

The secondary electrical service shall be 480 volts, 1 phase, 3 wire, 60 HZ, unless indicated otherwise on the plans. The overhead service entrance shall have five (5) feet of tailwire extension from the service entrance cap for

connection to the Utility Company's overhead transformer service facilities. An underground service entrance shall consist of conduit and wire placed, after coordination with the serving utility, in a manner to connect the secondary power controller with the ground mounted transformer. The system will be metered as per serving utility company's requirements.

Bonding and grounding of all electrical service equipment enclosures and ground terminals shall be as shown on the plans and/or in accordance with Article 250 of the National Electrical Code.

The secondary distribution shall consist of furnishing, installing, erecting and laying electrical branch circuits. All branch circuits shall be buried underground except where shown otherwise on the plans. Branch circuits shall consist of conduit, conductors, connectors, and all hardware necessary to complete the work. Pull boxes and junction boxes may be both underground and/or structure mounted.

The secondary power controller shall consist of a lighting controller for control of roadway lighting, enclosure, conduit with fittings, wire, devices, ground rods, photocell, and miscellaneous hardware. The controller shall have a dead front behind outer doors with only breaker handles, hand-off automatic selector switch and receptacle exposed. All controllers shall be labeled with a phenolic engraved label having 1/4-inch white letters on a black background. Example: "SPC#1".

682.02--Materials.

682.02.1--Secondary Distribution. The materials used in this construction shall meet the requirements of Subsection 723.02.

682.02.2--Secondary Power Controller. The materials used in this construction shall meet the requirements of Subsection 723.03.

682-03--Construction Requirements.

682.03.1--Grounding and Bonding System. Where conduit enters an enclosure, a bonding type bushing shall be used on all conduits with #6 AWG copper bonding conductors bonded to all conduits thence to equipment enclosure or ground bus.

The green equipment grounding terminal of all grounding type equipment shall be bonded to its equipment ground conductor with a properly sized green bonding conductor.

One (1) green equipment grounding conductor shall be pulled into all raceways, sized the same as the branch circuit conductors, or as noted on the plans. This conductor shall be bonded to box ground terminals, pole ground terminal, ground

bus of panel, cabinet, enclosures, and/or ground electrodes shown on the plans.

682.03.2--Secondary Distribution. All trenching shall be performed by mechanical means and all sides shall be straight and vertical. Width of trenches shall not exceed eight (8) inches on either side of placed branch circuit conduits. All backfill shall be made with a friable material which has been approved by a visual inspection of the Engineer. The Contractor shall seed trenched areas as directed by the Engineer.

All conduits shall be sized as shown on the plans, or where size is not indicated, the Engineer shall be consulted. All conduits shall be run 2' 0" outside of roadway shoulder lines where practicable. All conduit field bends shall be made in accordance with the National Electrical Code, Article 344 for metallic conduit, or Article 352 for non-metallic conduit. All upturned conduits shall be plugged or ends taped to prevent entrance of debris or moisture. A dry swab shall be pulled through each conduit to remove any debris or moisture before pulling wire.

All flexible conduit shall be liquid tight with proper liquid tight fittings.

Conduit mounts exposed on poles or other supports shall be supported at 5' 0" on center by two (2) hole straps.

Only approved lubricants which will be not harm the conductor insulation shall be used while pulling wires. Each branch circuit shall be labeled with a permanent pressure-sensitive label with proper numbers and letters for identification.

All connections shall be made in pole bases and controller panels unless otherwise shown on the plans. Splices shall be made using compression type splice connectors. All splices and connections shall be well taped to provide an insulation equal in rating and thickness to the conductor insulation as follows:

- 1st layer - flame retardant, cold and weather resistant vinyl plastic tape.
- 2nd layer - self fusing, rubber-based insulating compound laminated to all weather grade PVC backing, rated up to 600 volts.
- 3rd layer - same as 1st layer.

No splices shall be allowed in pull boxes. All runs shall be continuous from controller to pole and from pole to pole. The Contractor shall be responsible for purchasing continuous lengths of wire to achieve the above.

Approved jacking or boring methods shall be used where a branch circuit must be placed under an existing roadway. Boring operations shall be kept a minimum of two (2) feet from the edge of shoulder, and care shall be taken not to disturb existing pavement or edge drains. The use of water, which could undermine

pavements, shall not be permitted. The jacking or boring site must be returned to its undisturbed state upon completion of the operation. Jacking or boring operations and other incidentals necessary to this operation will be cost of Underground Branch Circuit, Jacked or Bored.

Contractor may jack or bore, or trench at paved ditches encountered on branch circuit runs. Where paved ditches are trenched, all concrete must be replaced at no additional cost to the Department.

682.03.3—Pull Boxes and Junction Boxes. Pull boxes and junction boxes shall be installed in accordance with the plans. The location of the boxes may be adjusted to accommodate field conditions with the approval of the Engineer.

682.03.4--Secondary Power Controller. The secondary power control unit shall be installed in accordance with the plans and shall present a neat and workmanlike finished appearance. The Contractor shall cooperate with utility in completion of unit.

682.04--Method of Measurement.

682.04.1--Secondary Distribution. Branch circuits shall be measured by the linear foot. The measurement being computed as follows:

Jacked or Bored - Horizontally along the length of the jacked section of conduit.

Underground - Horizontally along the trench lengths.

Structure mounted branch circuit - horizontally or vertically along the length of the sections of conduit installed.

No extra length will be allowed for risers to lighting assemblies or secondary power controllers. The terminals for measurement of lengths will be considered specifically as the center of lighting assemblies, power controllers, and junction boxes. Payment for branch circuit connectors, tape, etc. shall be included in payment allowed for the total length of branch circuits.

Hardware, fittings, support devices, excavation, sod, backfill, seeding and other incidentals will not be measured for separate payment, but shall be included in the contract unit price per linear foot for branch circuits.

Pull boxes and junction boxes will be measured as a unit quantity per each as detailed on the plans.

682.04.2--Secondary Power Controller. Secondary power controllers complete in place will be measured as unit quantities per each, which shall include all items necessary to complete the installation.

682.05--Basis of Payment.

682.05.1--Secondary Distribution. Branch circuits of the type specified, measured as prescribed above, will be paid for at contract unit price per linear foot; which price shall be full compensation for furnishing, installing, connecting, and excavating, trenching, backfilling and replacement of sod; for hardware, fittings and support devices; for final clean-up; and for all labor, tools, equipment and incidentals necessary to complete the work.

Pull boxes and junction boxes, as prescribed above, will be paid for at the contract unit price per each, which price shall be full compensation for furnishing, installing, and mounting; for hardware, fittings, supports; for final clean up; for labor, tools, equipment and incidentals necessary to complete the work.

682.05.2--Secondary Power Controller. Secondary power controllers, measured as prescribed above, will be paid for at the contract unit price per each, which price shall include all constructing, erecting, installing, testing, connecting, cleaning up and for all materials, equipment, labor and tools necessary to complete the work.

Payment will be made under:

- 682-A: Underground Branch Circuit, Size, No. of Conductors - per linear foot
- 682-B: Underground Branch Circuit, Jacked or Bored, Size,
No. of Conductors - per linear foot
- 682-C: Structure Mounted Branch Circuit, Size,
No. of Conductors - per linear foot
- 682-D: Type Pull Box - per each
- 682-E: Type Junction Box - per each
- 682-F: Secondary Power Controller - per each

SECTION 683 - LIGHTING ASSEMBLIES

683.01--Description. In additional to the requirements set forth in Section 681, lighting assemblies shall consist of high mast lighting assemblies, low mast lighting assemblies, underpass lighting assemblies and portable power units. High mast lighting assemblies shall consist of a pole, lowering device, luminaires, anchor bolts, lamps, and miscellaneous hardware. Low mast lighting assemblies shall consist of pole, arm, luminaire, anchor bolts, breakaway device,

lamp, and miscellaneous hardware. Underpass lighting assemblies shall consist of the luminaire, conduit box, lamp, fuses and miscellaneous hardware. The portable power unit shall consist of a heavy-duty industrial type reversible power unit, dry type transformer and hand held control unit.

683.02--Materials.

683.02.1--High Mast Lighting Assembly. The materials used in this construction shall meet the requirements of Subsection 723.04.

683.02.2--Low Mast Lighting Assembly. The materials used in this construction shall meet the requirements of Subsection 723.05.

683.02.3--Underpass Lighting Assembly. The materials used in this construction shall meet the requirements of Subsection 723.06.

683.02.4--Portable Power Unit. The materials used in this construction shall meet the requirements of Subsection 723.07.

683.03--Construction Requirements.

683.03.1--High Mast Lighting Assemblies.

683.03.1.1--Field Assembly of All Components. The pole section shall be fitted together and supported by blocks. The Contractor shall use the piece marks provided by the manufacturer. The proper joint overlap shall be provided and verified. The sections shall be lashed together by an approved method which will not damage galvanizing during erection. The wiring, lowering device, cables, and all components, except luminaires, shall be installed on the pole before erection, as per manufacturer's guidelines. No field welding is permitted on the pole shaft. Any damaged areas on the pole surface shall be coated with a zinc rich paint before erection.

683.03.1.2-Setting and Aligning Poles. The pole shall be lifted at a point as far above center of gravity as possible. The lifting shall be smooth, continuous and free of abrupt motions. The base shall be placed on pre-leveled nuts and supported by the crane until anchor bolt nuts are tightened. Cables or chains which may damage galvanizing shall not be tied to poles.

Poles shall be plumbed by the method shown on the plans. The plumbing shall be done early in the morning while minimum heat is affecting the pole and while there is no appreciable wind. After the pole is plumb, the anchor bolt nuts shall be tightened and secured against loosening by tightening the nuts until there is an abrading or coining of the base plate under the nut.

The space between the top of the foundation and the bottom of the base plate

shall be grouted a maximum of three (3) inches deep, making two (2) drainage openings with ¾-inch PVC pipe for internal condensate drainage.

683.03.1.3--Cable Installation. Care shall be taken to remove all twisting from hoisting cables before installation and/or operation of the lowering device.

683.03.2--Low Mast Lighting Assemblies.

683.03.2.1--General. All component parts of the low mast lighting assemblies shall be installed as per manufacturer's guidelines and this specification.

683.03.2.2--Setting and Aligning Poles. All wiring, luminaires, and other components shall be installed as per plans before pole erection. Poles shall be lifted into place on the foundation using prelevelled nuts for alignment. All poles shall be as nearly plumb as possible.

683.03.2.3--Alignment of Luminaires. Luminaires shall be installed and aligned to provide the proper lighting pattern on the roadway. Pavement overhang shall be one (1) foot for bracket arm type assemblies or as shown on the plans. Post top mounted assemblies shall be properly aimed.

683.03.3--Underpass Lighting Assemblies. All component parts of the underpass luminaire shall be installed as per manufacturer's guidelines and the plans.

683.03.4--Portable Power Unit. The power unit shall be constructed in accordance with Underwriters Laboratories Standards and shall be so listed.

683.10.4--Method of Measurement. High mast and low mast lighting assembly, of the type specified, will be measured as a unit quantity per each, which measurement shall include the pole, lowering device, luminaires, lamps, pole wiring, conduit, anchor bolts, ground rods and all other items necessary to complete installation.

Underpass lighting assembly, of the type specified, will be measured as a unit quantity per each, which shall include luminaire, lamp, wiring, conduit box, fuse, and mounting hardware.

The portable power unit, complete in place, will be measured as a unit quantity per each, which shall include all items necessary to complete the unit.

683.10.5--Basis of Payment. High mast and low mast lighting assembly, measured as prescribed above, will be paid for at the contract unit price per each, which price shall be full compensation for furnishing all materials, and for all construction, placing, erecting, installing, connecting, and testing; for poles, lowering device, luminaires, lamps, breakaways, ground rods, conduits, cable,

wiring and all hardware; for final cleaning up; and for all equipment, labor, tools, and incidentals necessary for completion of the work.

Underpass lighting assembly, measured as prescribed above, will be paid for at the contract unit price per each, which price shall be full compensation for furnishing all materials; for all construction, installing, connecting, and testing; for luminaires, lamps, conduit boxes, hardware, wiring, connectors, and miscellaneous hardware; for all tools, labor, equipment and incidentals necessary to complete the work.

Portable electric power unit, measured as prescribed above, complete and accepted, which price shall be full compensation for furnishing all equipment and materials; for power unit, transformer, attachment devices, remote control unit; and for all labor and incidentals necessary to complete the unit.

Payment will be made under:

683-A: Lighting Assembly, High Mast, <u>Type</u>	- per each
683-B: Lighting Assembly, Low Mast, <u>Type</u>	- per each
683-C: Lighting Assembly, Underpass, <u>Type</u>	- per each
683-D: Portable Electric Power Unit	- per each

SECTION 684 - POLE FOUNDATIONS

684.01--Description. In additional to the requirements set forth in Section 681, pole foundations shall be cast-in-place reinforced concrete pilings or driven piling of types and sizes detailed on the plans.

684.02--Materials. Concrete for pole foundations shall be Class "B" structural concrete.

All reinforcement steel shall be in accordance with Section 711 of the Standard Specifications. The sizes for the reinforcement shall be as shown on the plans.

Pilings will be in accordance with Section 719 of the Standard Specifications.

684.03--Construction Requirements. Pole foundations shall be constructed as per the details on the plans, these specifications and Section 803 of the Standard Specifications. Casings, as required, will be in accordance with Section 803 of the Standard Specifications.

Structure excavation for foundations shall be opened vertically in accordance

with Section 801 of the Standard Specifications. All reinforcement, conduits, and anchor bolts shall be set in place before any concrete is poured. Forming, casting, and curing shall be in accordance with Section 601 of the Standard Specifications.

Due to soil conditions in certain locations, as noted on the plans, concrete shall be placed with a tremie. When a tremie is used, it shall performed in accordance with the requirements in Subsection 804.03.9 of the Standard Specifications.

It may be necessary to used slip casing to keep the holes open. Casing will be required in portions of the holes that are not stable. Casings authorized by the Engineer shall be of suitable size and strength to accommodate the drilling equipment and to withstand ground-pressures and removal operations without deformation of the poured shaft. When removed, the casings shall revert to the Contractor for disposal.

684.04--Method of Measurement. Pole foundations of the size specified will be measured by the cubic yard, which measurement shall be the area bounded by the vertical planes of the neat lines of the foundation.

Slip casings will be measured by the linear foot from the ground elevation to the bottom of the strata needing to be cased.

Piling will be measured by the linear foot from the bottom of the pile to the top of the pile.

684.05--Basis of Payment. Pole foundations, measured as prescribed above, will be paid for at the contract unit price per cubic yard, which price shall include full compensation for concrete, structure excavation, and reinforcing steel; for placing, vibrating, curing, and installing; for final clean-up; and for all equipment, labor, tools and incidentals necessary to complete the work.

Slip casings, measured as prescribed above, will be paid for at the contract price per linear foot, which price shall be full compensation for all materials, tools, equipment, labor, and incidentals necessary to complete to work.

Piling, measured as prescribed above, will be paid for at the contract price per linear foot, which price shall be full compensation for all materials, tools, equipment, labor, and incidentals necessary to complete to work.

Payment will be made under:

- 684-A: Pole Foundations, __" Diameter
- per cubic yard
- 684-B: Slip Casings, __" Diameter
- per linear foot

SECTION 685 - TEMPORARY LIGHTING SYSTEM

685.01--Description. In addition to the requirements set forth in Section 681, a temporary lighting system shall consist of furnishing all materials, installing, erecting, constructing, and assembling same to insure a properly operating temporary lighting system in accordance with the plans and specifications. The work shall also include all maintenance associated with the completed lighting system, provision of service and electrical power for this system during the duration of the required lighting period, adjustment and relocation during traffic control phases and removal of the system at the completion of the required lighting period.

685.01.1--General. The Contractor shall make provisions with the serving utility company for all construction necessary by the utility for power service. It will be required that initial fees be paid to the utility for installation of wiring, transformers, cutouts, etc., before utility construction can begin.

The Contractor shall be responsible for repairing all malfunctions in the system due to equipment failure, vandalism, accidents, etc., including all parts, labor, equipment and incidentals necessary to maintain the system. The Contractor shall also be responsible for all utility company costs for removal of the service upon completion of the project at no additional costs to the State.

The system shall be in fully operating condition during all hours of darkness for the duration of the required lighting period.

All electrical materials and operations for complete and operative systems shall be as follows and hereinbefore specified.

Lighting systems complete with fixtures, lamps, poles, switches, conduits, and wiring shall be provided.

The Contractor shall provide for power requirements and final electrical connections to all lighting systems, relocations required by traffic control phasing and removal of systems at completion of project.

685.01.2--Secondary Electrical Service. The temporary lighting service shall be 240-Volt, 1-phase, 3-wire, 60-hertz or as noted on the plans.

The Contractor shall pay all costs for electricity required by the lighting system during the duration of the project at no additional cost to the State.

The system shall be metered. Meter base shall be of a type approved by serving

utility company. The Contractor shall pay all costs associated with system metering at no additional cost to the State.

685.01.3--Removal of Materials. Upon completion of the project in conjunction with removal of the temporary roadways and traffic control devices, the Contractor shall disconnect and remove the traffic control lighting system. All materials shall be the property of the Contractor.

The Contractor shall also be responsible for all costs incurred by the utility company for removal of utility company services.

685.02--Materials. Materials for temporary lighting systems shall meet the requirements of Subsection 723.08.

685.03--Construction Requirements. All component parts of the temporary traffic control lighting system shall be installed as shown on the plans and required by construction procedures.

685.04--Method of Measurement. Electrical cable of the type specified shall be measured by the linear foot. Measurement shall be computed horizontally from terminal to terminal along the circuits. No extra lengths will be measured for risers to lighting assemblies or any other terminals.

Temporary lighting assembly shall be measured as a unit quantity per each. Measurement shall include fixture, junction box, wiring, pole, ground rod, bracket, lamp and all other items necessary to complete the installation.

Service pole shall be measured per each. Measurement shall include pole, wiring, conduit, supporting devices, ground rod, hardware, safety switch, fuses, utility company service provisions, electrical power and all other items necessary to complete the installation.

685.05--Basis of Payment. Electrical cable, measured as prescribed above, will be paid for at the contract unit price per linear foot; which price shall be full compensation for furnishing, installing, connecting and testing and maintaining all materials; for supporting devices; for final clean-up; and for all labor, equipment, tools, and incidentals necessary to complete the work and for removal of materials upon completion of project.

Temporary lighting assembly, measured as prescribed above, will be paid for at the contract unit price per each, which price shall be full compensation for furnishing all materials; for excavation, back-filling, replacing sod, and for all construction, placing, erecting, installing, connecting, testing, and maintaining; junction boxes for poles, brackets, luminaires including lamps and ballast, ground rods, conduits, hardware, cable, for adjustments, replacement of equipment or material which malfunctions, for final cleaning up; and for all

equipment, labor, tools, and incidentals necessary to complete the work, and for removal of materials upon completion of project.

Service pole, measured as prescribed above, will be paid for at the contract unit price per each, which price shall be full compensation for furnishing all materials for all construction, placing, erecting, installing, connecting and testing; for utility company up/down costs, electrical power, pole, safety switch, wiring, fuses, conduit, ground rod, supporting devices and all hardware, for adjustments, replacement of defective equipment, for final clean-up equipment, labor, tools and incidentals necessary to complete the work, and for removal upon completion of the project.

Payment will be made under:

- 685-A: Underground Electric Cable, Type, AWG #,
No. of Conductors - per linear foot
- 685-B: Aerially Supported Electric Cable, Type, AWG #,
No. of Conductors - per linear foot
- 685-C: Temporary Lighting Assembly, Type - per each
- 685-D: Service Pole - per each

SECTION 686 - RELOCATION OF EXISTING LIGHTING ASSEMBLIES

686.01--Description. In additional to the requirements set forth in Section 681, relocation of existing lighting assemblies of the types indicated on the plans shall consist of removing and relocating pole, luminaire, providing new foundation and miscellaneous hardware. Wiring shall be reworked or replaced as directed below and on the plans.

686.02--Materials. Generally, all the materials needed to relocate the lighting assembly(ies) will be existing materials. The lighting assemblies, wire and foundations may be either permanent or temporary. Wiring, ground rods, bolts and other items shall be relocated as per the plans. Additional items necessary for a complete working lighting assembly shall be required whether or not mentioned in these specifications.

686.02.1--Poles. Steel poles are hot-rolled weldable grade steel, galvanized in accordance with ASTM Designation: A 123, length as indicated on the plans. Since the anchor bolt layout may vary from pole to pole, the Contractor shall field verify bolt circles of existing lighting assemblies.

Timber poles, used on temporary lighting systems, shall conform with the

applicable requirements of Section 685. Voids left by the removal of these poles shall be filled and compacted as directed by the Engineer.

686.02.2--Luminaire. Low mast luminaires are bracket arm mounted type, 250 or 400-watt, high pressure sodium. The Contractor shall verify luminaire lamp wattage that may be stated on the plans. High mast luminaires are 1000-watt high pressure sodium.

The Contractor will be required to install new 250-watt, 400-watt or 1000-watt clear high pressure sodium lamps as indicated on the plans.

The fixtures shall be cleaned and refurbished before re-installing. Any inoperative ballasts shall be replaced. The luminaire is to be in good working order when re-installed.

686.02.3--Pole Foundations. Pole foundations are cast-in-place concrete. The removal of the foundations shall be as detailed in other sections of the specifications.

New foundations shall be cast-in-place as per Section 684 or as per plans.

686.02.4--Anchor Bolts. The Contractor will be required to install new anchor bolts. Anchor bolts shall be galvanized as per ASTM Designation: A 123. The minimum yield strength of the anchor bolts shall be 50,000 psi. The new anchor bolts shall be of the same design as the existing bolts.

686.03--Construction Requirements. All component parts of the lighting assemblies shall be removed and relocated as shown on the plans and required by the new construction procedures. When an item is removed it shall be stored in a location approved by the Engineer. All items scheduled to be re-installed shall be safeguarded by the Contractor and shall be fully operational at the end of the project.

686.03.1--Branch Circuit Wiring. All existing wiring in place will be shown on the plans. The Contractor shall verify the type and size. For relocation and maintenance purposes, splicing of permanent wiring will not be permitted. New branch circuit wiring shall be provided as detailed on the plans.

Splices of permanent wiring are permitted in pole bases only. Temporary wiring may be spliced as needed. All wiring shall meet the requirements of the National Electrical Code (NEC).

The re-use of existing conductors and conduit when relocating permanent wiring will not be permitted. New conductors, conduit, boxes, connectors, etc. shall be provided as detailed on the plans. New wiring installation and materials shall be as per specified for underground branch circuit elsewhere in these specifications.

Temporary wire may be re-used as long as it meets the requirements of the NEC.

686.03.2--Maintenance of Service. The existing lighting system shall be maintained and kept in operation during the duration of the project. The Contractor shall provide and install any and all materials required to keep the lighting system in operation through the duration of the contract. Existing disconnected underground circuit conductors shall be cut off 24 inches below grade and abandoned.

686.04--Method of Measurement. Relocation of existing lighting assembly will be measured as a unit quantity per each. Relocation of existing wiring will be measured per linear foot.

686.05--Basis of Payment. Relocation of existing lighting assembly, measured as prescribed above, will be paid for at the contract unit price per each, which price shall be full compensation for furnishing all new materials required, for excavation, backfill, sod replacement, construction, placing, reconnecting, and for testing; for all equipment, tools, labor, final clean up and incidentals necessary for completion of the work.

Relocation of existing wiring, measured as prescribed above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for furnishing all material; for trenching, backfilling, disconnecting, reconnecting, replacing sod and for all construction, testing, installing, and for all conductors, conduit, J-boxes, connectors and miscellaneous materials; for final clean-up, tools, labor, equipment and incidentals necessary for completion of the work.

Payment will be made under:

686-A: Relocation of Existing Lighting Assembly - per each

686-B: Relocation of Existing Wiring - per linear foot

**SECTION 690 - DECOMMISSIONING OF ABANDONED
OR UNUSED WATER WELLS**

690.01--Description. This work is applicable to abandoned or unused water wells over 25 feet deep and shall consist of plugging with portland cement grout the aforementioned water wells in accordance with current, as amended, Surface Water and Ground Water Use and Protection Regulations issued by the State of Mississippi Department of Environmental Quality, Office of Land and Water Resources. The work shall be performed by a water well Contractor so licensed by the State of Mississippi.

The preliminary plan quantity for this item of work is based on a theoretical yield

of 1.213 cubic feet of grout per bag of portland cement and an estimated depth of 300 feet for each of the wells.

Well locations shall be adequately marked by the Contractor prior to clearing and grubbing. The markings shall be maintained during construction.

Water wells in addition to those listed in the plans may be discovered on the project during the course of construction. The Contractor shall decommission any additional wells with payment made at the contract unit price bid for Grouting Abandoned Water Wells.

690.02--Materials. The materials used in this construction, when sampled and tested in accordance with Subsection 700.03, shall meet the requirements of the following Subsections:

Portland Cement	701.01, 701.02 & 804.02.5
Water	714.01.1 & 714.01.2

690.02.1--Grout Mix Design. The grout mixture shall be composed of one bag (94 lbs.) of portland cement to 5½ gallons of water.

690.03--Construction Requirements. The abandoned or unused water wells shall have obstructions removed from the well casing prior to grouting.

The casing shall be pulled or reamed. If the casing cannot be removed and unless it is known that the annular space was grouted during construction of the well, then the casing shall be perforated and grout shall be forced under pressure into the annular space during the plugging operation.

Casing not removed shall be cut off a minimum of three (3) feet below finish subgrade elevation, finish slope elevation or natural ground, whichever is applicable, depending on the location of the well with regard to the roadway typical section at the well site.

The well shall be grouted from the bottom of the hole to the top of the cut off casing for instances where the casing is not removed and from the bottom of the hole to three (3) feet below finish subgrade elevation, finish slope elevation or natural ground, whichever is applicable, for instances where the casing is removed.

Free-fall placement of grout is prohibited.

The Haliburton Method, which consists of forcing grout under pressure, from inside the casing, out the bottom and up the outside of the casing, filling the annular spaces and at the same time, filling the casing, is considered an acceptable alternate method to that otherwise indicated herein for the grouting

operation associated with decommissioning water wells.

When the Haliburton Method is proposed for use, the Contractor shall furnish the Project Engineer with the details of this method prior to performing the work.

Excavations made in association with this work shall be backfilled and compacted following completion of plugging operations.

Within thirty days after completion of the plugging operation, the Contractor shall complete a Well Decommissioning Form and submit copies to the Office of Land and Water Resources and to the Mississippi Department of Transportation Project Engineer. Well decommissioning forms are available from the Office of Land and Water Resources.

690.04--Method of Measurement. Grouting abandoned water wells will be measured by the pound of portland cement incorporated into the grout mixture used to plug the well.

Water incorporated into the grout mixture will not be measured for separate payment.

690.05--Basis of Payment. Grouting abandoned water wells will be paid for at the contract unit price per pound of portland cement incorporated into the grout mixture used to plug the well, which price shall be full compensation for furnishing materials to be incorporated into the specified grout mixture; for all hauling, mixing, placing, and clean-up required to plug the well; for removing obstructions from the casing; for pulling and disposing of, reaming or perforating the casing as required; for the cutting off and disposal of cut off casing; for removal and disposal of water pipe, well pump, water tank, electrical wiring or other miscellaneous obstructions at the site; for excavation, backfill and compaction associated with this work; and for all equipment, tools, labor and incidentals necessary to complete the work.

Payment will be made under:

690-A: Grouting Abandoned Water Wells - per pound

SECTION 699 - CONSTRUCTION STAKES

699.01--Description. This work consists of performing all calculations and other work necessary to establish and/or verify all horizontal and vertical control data; and furnishing, placing and maintaining roadway construction stakes or bridge construction stakes, or both, necessary for the proper prosecution of all features and items of the work under contract. This shall include, but not be limited to, grades and drainage structure locations, lengths, elevations and skews. When the

contract includes a pay item for roadway construction stakes as provided herein, any references in other sections of the Standard Specifications to establishment of control points or construction staking "by the Department" shall be construed to mean "by the Contractor".

699.02--Materials. The Contractor shall furnish all personnel, materials, equipment and devices necessary for determining, establishing, setting, checking and maintaining points, lines, grades and layout of the work. All surveying equipment shall be properly adjusted and suited for performing the work required. Traffic control necessary for the proper execution of the work shall be furnished by the Contractor without separate measurement for payment. Stakes shall be of sufficient length, thickness and quality to serve the purpose for which they are being used.

699.03--Construction Requirements. The Department will establish, one time only, reference points and bench marks at distances not to exceed 1000 feet for roadway work. For bridge work, the Engineer's field control will consist of a stationed baseline reference point near each end of the bridge(s) and one accessible bench mark near each bridge site. For the purpose of determining responsibility for construction stakes, lines and grades, a box bridge will not be considered as a bridge. The Contractor shall verify the accuracy of the control points before proceeding with the layout for construction.

When errors are discovered and control points do not agree with the plans, the Contractor shall promptly notify the Engineer in writing, and explain the problem in detail. The Engineer will advise the Contractor within five (5) working days of any corrective actions which may be deemed necessary.

The Contractor will be responsible for verifying and modifying, as necessary to best fit existing field conditions, lengths, locations, elevations and skew angles of all drainage structures shown on the construction plans. All junction box and inlet locations and heights shall also be verified and modified as necessary to fit existing field conditions. Modifications to the plans shall not be made without the consent of the Project Engineer. The Contractor will not be responsible for determining the size of drainage structures, but should immediately report any suspected error to the Engineer. Heights of fill over drainage structures shall be checked to verify class of pipe, bedding and the appropriate standard and/or modified standard drawing(s) required in the construction with any differences from the plans being reported to the Engineer.

The Contractor shall perform work necessary to verify alignment and plan grades on all roadway intersections and tie-ins. Any discrepancies in grades, alignment, location and or dimension detected by the Contractor shall immediately be brought to the attention of the Project Engineer.

The Contractor shall employ sufficient qualified personnel experienced in

highway surveying and layout to complete the work accurately. The Contractor shall also determine and provide all additional grade controls and staking operations necessary to secure a correct layout and construction of the work. All minor variations in layout and grades required to meet field conditions shall be resolved with the Engineer and shall not be considered justification for adjusting contract price or time.

Examples of minor variations in layout and grades are:

- (a) Adjustment of drainage or other structure length, alignment, and flow line elevation.
- (b) The adjustment of grades and alignment at roadway intersections, cross-overs, railroad crossings, interchanges, existing bridges and roadways.
- (c) Adjustment of curve data.

The Contractor will be responsible for calculating and laying out all additional lines, grades, elevations and dimensions necessary to construct the work required in the plans. All grades and other layout data computed by the Contractor shall be recorded and a copy of this data shall be furnished, with sufficient time for checking, to the Engineer before field work is started. The originals of all data shall be furnished to the Engineer on or before final inspection for the Department's permanent file. The Contractor shall also furnish personnel to assist the Engineer in taking stringline or other notes to determine whether specified tolerances are met. Any inspection or checking of the Contractor's layout by the Engineer and the approval of all or any part of it will not relieve the Contractor of the responsibility to secure proper dimensions, grades, and elevations of the several parts of the work.

Prior to beginning construction on any structure which is referenced to an existing structure or topographical feature, the Contractor shall check the pertinent location and grades of the existing structures or topographical features to determine whether the location and grade shown on the plans are correct.

The Contractor shall stake centerline control at each station, BOP, EOP, PC, PT, SC, CS, TS, ST, and equations just before field cross sectioning by the Department for both original and final cross sections.

The Contractor shall furnish "as built" finish centerline elevations to the Project Engineer prior to final inspection of the project.

The Contractor shall set stakes and/or flags on the right-of-way line at each station and right-of-way break or as directed by the Engineer before clearing operations are started on any section of roadway.

On grading projects, the Contractor shall set slope stakes at each station and at the beginning and end of spirals and curves. Closer intervals will be required for sharp changes in grades or alignment, widening and certain other geometric details.

The Contractor shall set subgrade blue tops on centerline, break points and at the left and right subgrade shoulder lines at intervals of not more than 100 feet on tangents and intervals of not more than 50 feet in curves. Closer intervals will be required for sharp changes in grades or alignment, widening, or super elevation.

On paving contracts, the Contractor shall set subgrade, base and paving blue tops. The base and pavement blue tops shall be set on intervals in accordance with the appropriate applicable requirements of Sections 321, 403 and 501.

The Contractor shall exercise care in the preservation of stakes and bench marks and shall reset them when they are damaged, lost, displaced or removed. The Contractor shall use competent personnel and suitable equipment for the layout work required and shall provide that it be performed under the supervision of, or directed by, a Registered Professional Engineer or Registered Land Surveyor who is duly registered and entitled to practice as a Professional Engineer or Professional Land Surveyor in the State of Mississippi. The duties performed by said Registrant shall conform to the definitions under the “practice of engineering” and practice of “land surveying” in Mississippi Law. The Contractor shall not engage the services of any person in the employ of the Department for the performance of any of the work covered by this Section or any person who has been employed by the Department within the past six months except those who have legitimately retired from service with the Department during this period.

All cross sections, measurements, and tickets required for determining pay quantities will be the responsibility of the Department.

The Department reserves the right to check for accuracy any or all of the Contractor's layout work and shall be assisted by the Contractor's personnel in such checking. When errors or discrepancies are found, the Contractor will take measures necessary to correct, at no expense to the State, any construction that has been performed using the improper layout. Any inspection, checking and approval thereof by the Engineer of work for which the Contractor is responsible will not relieve the Contractor of responsibility to secure correct dimensions, grades, elevations, alignments and locations of the work for satisfactory completion of the project and as a condition for final acceptance by the Department.

699.04--Method of Measurement. Construction stakes will be measured as a lump sum quantity. When Pay Item No. 699-A, Roadway Construction Stakes, is provided in the contract, measurement shall include the staking of all bridges,

including detour bridges, which are a part of the contract.

699.04.1--Roadway Construction Stakes. Measurement for payment will be in accordance with the following schedule:

- (a) When one percent of the original contract amount is earned from all direct pay items, 10 percent of the amount bid for Roadway Construction Stakes will be paid.
- (b) When five percent of the original contract amount is earned from all direct pay items, 25 percent of the amount bid for Roadway Construction Stakes will be paid.
- (c) When 20 percent of the original contract amount is earned from all direct pay items, 50 percent of the amount bid for Roadway Construction Stakes will be paid.
- (d) After the Contractor has earned 50 percent of the original value of all direct pay items, the amount paid will be based on the contract percent complete.

699.04.2--Bridge Construction Stakes. Measurement for payment will be in accordance with the following schedule:

- (a) When one percent of the original contract value of all bridge items is earned, 10 percent of the amount bid for Bridge Construction Stakes will be paid.
- (b) When five percent of the original contract value of all bridge items is earned, 25 percent of the amount bid for Bridge Construction Stakes will be paid.
- (c) When 20 percent of the original contract value of all bridge items is earned, 50 percent of the amount bid for Bridge Construction Stakes will be paid.
- (d) After the Contractor has earned 50 percent of original contract value of all bridge items, the amount paid will be based on the percentage of work completed on all bridge items.

699.05--Basis of Payment. Construction stakes, measured as prescribed above, will be paid for at the contract lump sum price, which shall be full compensation for completing the work.

Payment will be made under:

699-A: Roadway Construction Stakes	- lump sum
699-B: Bridge Construction Stakes	- lump sum

DIVISION 700 - MATERIALS AND TESTS

700.01--General. Materials will be inspected and sampled in accordance with current Department SOP pertaining to inspecting and sampling.

Unless otherwise provided, all materials furnished which are to remain in place after final acceptance shall be new and unused before incorporation into the work, except that crushed reclaimed concrete pavement meeting the requirements of Section 703, as amended, may be used to produce aggregate for all hot mix asphalt pavements. When allowed by the specifications, Recycled Asphalt Pavement (RAP) may be used in the manufacture of hot mix asphalt pavements. Other recycled products approved for use by the Department may be incorporated in the work.

The Contractor shall maintain sufficient approved materials on hand so that delays to the work will not result from the necessary sampling, testing, and evaluation of test results.

Domestic steel, iron and wire products including prestressing cable and strand shall be furnished for incorporation in the work. All manufacturing processes, including application of a coating, for these materials must occur domestically. However, pig iron and processed, pelletized, and reduced iron ore manufactured outside of the United States may be used in the domestic manufacturing process for steel and/or iron products. For the purpose of this specification, the activity of coating is considered a manufacturing process. The material being applied as a coating is not covered under Buy America. Coating includes all processes which protect or enhance the value of the material to which the coating is applied, such as epoxy coatings, galvanizing, painting, etc.

Domestic shall be understood to mean all States of the United States, District of Columbia, Puerto Rico, American Samoa, Guam, the Virgin Islands and any other place subject to the jurisdiction of the United States.

In the case of coatings for the above referenced domestic steel, iron and wire products, it shall be the Contractor's responsibility to forward to the State Materials Engineer a certified statement from those having applied a coating to these materials that the application of the coating occurred domestically.

It shall be Contractor's responsibility to forward to the State Materials Engineer such acceptable certification from the manufacturer, or at the election of the State Materials Engineer, such certification may be acceptable directly from a manufacturer annually, or more often, when requested by the State Materials Engineer.

700.02--Glossary of Terms and Definitions.

Aggregate - Inert material such as sand, gravel, lightweight aggregates, broken stone, slag, shell, or combinations thereof.

Argillaceous - Containing or consisting of clay.

Asphaltic Cement - A product of the refining of crude oil to form a residue which is used usually without the addition of more than a small quantity of flux or any liquefying agent of a higher volatile material than the residue itself.

Calcareous Material - A material containing more than 50 percent calcium type material.

Cementitious Material - Portland cement, or blend of portland cement and pozzolan material used as the bonding agent in portland cement concrete. Cementitious shall mean "as having cementing properties".

Clay - The fraction of a soil finer than 0.005 mm that is more or less plastic when wet.

Compaction - The process of obtaining the density of a soil or material.

Crusher Run - The product of a crushing plant that has not been rescreened or separated into various sizes.

Cutback Asphalt - An asphaltic material obtained from the refining of petroleum by adding to or fluxing the residue from distillation with volatile petroleum fractions to produce a uniform mixture which is capable of becoming quite fluid at relatively low temperatures.

Fineness Modulus - An empirical factor obtained by adding the total percentages of aggregate retained on the Nos. 100, 50, 30, 16, 8, 4, 3/8", 3/4", 1 1/2", and 3" sieves and dividing the sum by 100.

Frame - The part of the work or materials for which the same quality characteristics are specified, such as a base course, an aggregate stockpile, a hot bituminous pavement course, etc.

Gravel - The granular, pebbly material, usually retained on a No. 8 sieve, resulting from the natural disintegration of rock.

Increment - The smallest unit(s) set aside for the sampling and testing process.

Loess - Wind-blown, yellowish-brown loam having little or no stratification.

Lot - A subdivision of a frame, representing a designated quantity of work or materials, and is the unit of such work or materials which will be accepted or

rejected.

Liquid Limit (LL) - The water content, expressed in percentage by weight of the oven-dried soil, at which the soil passes from a plastic to a liquid state when subjected to a standard method of determining liquid limit of soils.

Mechanical Analysis - The determination of the size and grading of soil particles by standard tests.

Optimum Moisture - The moisture content necessary to obtain the standard density of a soil.

Overburden - Refers to soil or similar material directly above a deposit of rock, sand, gravel, or select material.

Pea Gravel - That portion of uncrushed gravel passing a 3/8 inch sieve and retained on a No. 8 sieve.

Plastic Limit (PL) - The water content, expressed in percentage by weight of the oven-dried soil, at which a soil passes from a solid or semi-solid state to a plastic state when subjected to a standard method of determining plastic limit of soils.

Plasticity Index (PI) - The range of water content through which the soil remains in a plastic condition. This term is the numerical difference between the liquid limit and plastic limit and is a measure of cohesion.

Portland Cement Concrete - A concrete mixture composed of cementitious materials, water, fine aggregate, coarse aggregate and possibly admixture(s).

Sample - The portion taken from a lot and considered to represent the whole or a designated portion of the lot. It may consist of one or more increments or a fractional part of one or more combined increments.

Sand - A fine granular material resulting from the natural or mechanical disintegration of rock. Depending on its use, material may be classed as sand if it passes the 3/8 inch, No. 4 or No. 10 sieve.

Sand Clay - A mixture of sand and clay often found blended so that their opposite qualities tend to maintain a condition of stability under varying moisture contents.

Screenings - Broken rock, limestone, slag, or other material, including the dust, of a size that will pass a 1/2 inch sieve.

Selected Material - Material from State-furnished or optioned sources, for use in bases, or for other specified use.

Shale - A fissile rock formed by the consolidation of clay, mud, or silt having a finely stratified or laminated structure.

Shrinkage Limit (SL) - The maximum calculated water content of a soil at which a reduction in water content will not cause a decrease in the volume of the soil mass.

Sieves - Sieves for testing purposes conforming to the requirements of the Standard Specifications for Sieves for Testing Purposes of the AASHTO Designation: M 92.

Silt - The finer particles of organic or rock substance, ranging in size from 0.05 mm to 0.005 mm.

Slag - The nonmetallic product thrown off from molten ore or metal or other processes and used as fine or coarse aggregate.

Soil - A natural aggregate of mineral grains, with or without organic constituents, that can be separated by gentle mechanical means such as agitation in water.

Spall - A relatively small piece or fragment broken from rock, concrete, or other material.

Specific Gravity - The ratio of the weight of a volume of some substance to the weight of an equal volume of substance, usually water, taken as a standard or unit.

Standard Density (Standard Compaction) - The maximum dry unit weight in pounds per cubic foot obtained by the compactive effort exerted under the applicable test designation as provided in Subsection 700.03.

Sublot - The smallest unit(s) set aside from a lot for the sampling and testing process.

Test Portion - The actual quantity of material tested which may be, in some instances, the whole of the sample or, in other instances, only a quartered or other portion of the sample.

Test Result - The value of the specified characteristic obtained from testing a single test portion.

Test Value - The value determined as being the test result when only one test is required to satisfy a specified condition, or the average of the test results on two or more test portions of a lot, or a designated portion thereof.

Volume Change (VC) - The decrease in volume of the soil mass when the water

content is reduced from a given percentage to the shrinkage limit.

Water-Cement Ratio - The ratio of the weight of water used, including free moisture in the aggregate, to the weight of cementitious material.

Other Definitions - Other applicable definitions as prepared by the Special Committee on Nomenclature and adopted by AASHTO.

700.03--Sampling and Testing. Sampling and testing for acceptance and control of materials may be performed at any time prior to incorporation in the work. Sampling and testing for control and acceptance of a work item will be performed progressively as sections of the work item are being constructed or completed, as applicable.

Unless otherwise designated, all tests will be made in accordance with applicable standard methods of AASHTO, ASTM, Federal Specifications, or approved Mississippi Test Methods (MT-_____) in effect on the date of advertisement for bids. Note: It is contemplated that certain methods of testing will be developed by the Department. These will generally consist of minor revisions of AASHTO or ASTM Methods and will be designed to more nearly fit local conditions. Such methods are designated MT-_____. As such methods are developed, approved, and issued, they will be used as standards in field testing or in the Central Laboratory, as designated in the method, on projects advertised subsequent to their approval and issuance.

Material requiring specified tests used by a plant for producing composite material(s) or product(s) to be used in the work will be tested and approved by the Engineer. If such materials, composite materials, or products are stored separately for the exclusive use in the work, the cost of testing will be borne by the Department. If such materials, composite materials or products are not stored separately for the exclusive use in the work, the cost of testing shall be borne as set out in the Department's issued SOP in effect at the time bids are received.

700.04--Determination of Conformity. The determination of conformity with each required measurable characteristic under the intent of Subsection 105.03 will be made in accordance with the following:

All test values or test results used to determine compliance will be rounded off to the nearest decimal point as expressed in the specifications for the particular characteristic under consideration. Fractions beyond the point of rounding amounting to less than 0.50 will be dropped. Similar fractions amounting to more than 0.50 will be rounded off by increasing the last digit within the rounding. Similar fractions amounting to even 0.50 will be rounded toward the specifications by dropping or by increasing the last digit within the rounding, as applicable.

The various frames of materials or work will be divided into lots as specified in the contract or conforming to the Department's SOP for frequency of sampling and testing.

In the case of borderline quality products or a demonstrated trend toward borderline quality products, the Engineer will require the Contractor to improve the quality of the materials or work to more nearly conform to the specifications and may require a suspension of the operations which have resulted in the borderline product or the trend toward borderline quality until such corrective measures have been taken as deemed necessary to produce the contemplated quality products.

All increments of tests for determination of acceptance will be taken by random sampling. However, during or as a result of visual inspection, the Engineer will take increments for testing for progress checks or spot checks at any time and place the Engineer may deem necessary to determine weak spots or other progress information. The results of any such progress or spot checks may be used to determine whether or not additional work or corrective action is considered necessary prior to acceptance testing.

Minimum and maximum requirements in these specifications are set out on the basis that the desirable average test value of the materials or work is appreciably above the minimum requirement or appreciably below the maximum requirement established.

700.05--Material Certifications and Certified Test Reports. All certifications and certified test reports shall meet the requirements set forth herein except certification requirements for cement and asphalt are set out separately in Department SOP TMD-21-01-00-000 and TMD-22-01-00-000.

700.05.1--Certifications. All certifications shall:

- (a) Have letterhead of the manufacturer, producer, supplier, or fabricator.
- (b) Include the project number.
- (c) Itemized list of materials covered by the certification.
- (d) Contain a material conformance statement which certifies that the materials conform to the specific specification requirements. Example: I/We hereby certify the materials listed herein conform to the requirements of Subsection 714.14 of the Mississippi Standard Specifications for Road and Bridge Construction.
- (e) Certification for all iron, steel and steel wire products must also include a certified statement by the manufacturer that all of the manufacturing

processes, excluding those for pig iron and processed, pelletized, and reduced iron ore used in the manufacture of said steel and/or iron products, have occurred domestically.

(f) Signature of a responsible company official.

700.05.2--Certified Test Reports. All certified test reports shall:

- (a) Have letterhead of the manufacturer, producer, supplier, fabricator, or laboratory.
- (b) Include name and description of material, lot, batch or heat number, etc., as applicable.
- (c) Show results of each required test, and state that the test was run according to the test method specified.
- (d) Test reports for all iron, steel and steel wire products must also include a certified statement by the manufacturer that all of the manufacturing processes, excluding those for pig iron and processed, pelletized, and reduced iron ore used in the manufacture of said steel and/or iron products, have occurred domestically.
- (e) Signature of the responsible laboratory official.

SECTION 701 - HYDRAULIC CEMENT

701.01--General. The following requirements shall be applicable to hydraulic cement:

Different brands of cement, or the same brand of cement from different mills, shall not be mixed or used alternately in any one class of construction or structure, without written permission from the Engineer; except that this requirement will not be applicable to cement treatment of design soils, or bases.

The Contractor shall provide suitable means for storing and protecting the cement against dampness. Cement, which for any reason, has become partially set or which contains lumps of caked cement will be rejected. Cement salvaged from discarded or used bags shall not be used.

The temperature of bulk cement shall not be greater than 165°F at the time of incorporation in the mix.

One barrel (bbl) of cement shall be equivalent to four bags or 376 pounds.

Low-alkali cement, with maximum sodium and potassium oxides of 0.6%, will be furnished in all types.

Except when otherwise specified or prohibited, either Type I, IP or II portland cement shall be used. Type III portland cement may be used in the production of precast or prestressed concrete members.

Acceptance of hydraulic cement will be based on the certification program and job control sampling and testing as established by Department SOP.

Retests of cement may be made for soundness and expansion within 28 days of test failure and, if the cement passes, it may be accepted. Cement shall not be rejected due to failure to meet the fineness requirements if upon retests after drying at 100°C for one hour, it meets such requirements.

701.02--Portland Cement. Portland cement shall conform to Subsection 701.01 and AASHTO Designation: M 85 with the following exceptions:

The maximum values for the fineness of the grind as set out in Table 2 of AASHTO Designation: M 85 are hereby waived for Type I cement to be used in the production of prestressed concrete members.

When Portland cement concrete or cement for soil stabilization is exposed to moderate or severe soluble sulfates, or to seawater, cement types and/or replacement of cement by Class F fly ash (FA) or ground granulated blast furnace slag (GGBFS) shall be as follows:

Cementitious Materials for Soluble Sulfate Conditions

Sulfate Exposure	Water-soluble sulfate (SO ₄) in soil, % by mass	Sulfate (SO ₄) in water, ppm	Cementitious material required
Moderate and Seawater	0.10 - 0.20	150 - 1500	Type II cement or Type I cement with 25% Class F, FA or 50% GGBFS replacement
Severe	0.20 - 2.00	1500 - 10,000	Type II cement with 25% Class F, FA or 50% GGBFS replacement

701.03--Masonry Cement. Masonry cement shall conform to Subsection 701.01 and ASTM Designation: C 91.

701.04--Blended Hydraulic Cement. When permitted in the contract, blended hydraulic cement shall conform to Subsection 701.01 and AASHTO Designation: M 240.

SECTION 702 - BITUMINOUS MATERIALS

702.01--General. Bituminous materials shall include asphalt cement, cutback asphalt, or emulsified asphalt and shall meet the requirements of the applicable specifications. The material furnished for any item in any one contract shall be of one brand, type, and grade, unless special permission is obtained otherwise. Materials furnished shall exhibit uniform characteristics.

When more than one grade of material is called for under any item, the Engineer will select the grade to be used.

All sampling and reporting of bituminous materials shall be performed as set out in the Department's Standard Operating Procedures. All testing shall be performed in accordance with applicable AASHTO methods unless specifically modified by a Mississippi Test Method (MT- _____).

Bituminous material shall not be heated to a temperature which causes injury as evidenced by the formation of carbonized particles.

702.02--Measurement. Volumetric measurement of bituminous materials by the U.S. gallon will be based upon a temperature of 60°F. Corrections to this temperature for asphalt cement, cutback asphalts and emulsified asphalt will be made in accordance with the Temperature Correction Tables set out in the Department Standard Operating Procedures.

For purposes of measurement, a U.S. gallon shall be a volume of 231 cubic inches.

When bituminous material is to be paid for by the gallon, the distributor tank(s) or storage tank(s), as applicable, to be used for measurement shall be calibrated by an agency and in a manner approved by the Department. A calibration chart, showing the dimensions and volume per inch of depth, and a measuring gauge, calibrated in inches, shall be furnished to the Engineer. Each tank shall have an identifying serial number on a steel plate welded or riveted to the tank. In the event the Contractor does not have such calibration chart, previously made by an approved agency, the Department will, upon request, perform the calibration and furnish required charts; however, the Contractor will be fully responsible for any delays occasioned by such calibration by the Department.

The measurements shall be taken when the bituminous material is of a uniform temperature and free of air bubbles. In no case shall the total number of gallons of bituminous material allowed for any tank exceed the capacity of the tank as rated by either the U. S. Interstate Commerce Commission, the State Tax Commission or the Department of Transportation.

702.03--Heating Bituminous Material. Tanks for heating and storage of

bituminous materials shall be capable of heating the material to the specified temperature under effective and positive control at all times. The heating system shall provide uniform heating for the entire contents of the tank. The circulating system shall be of adequate size to insure proper and continuous circulation of the material during the entire operating period. Suitable means shall be provided, either by steamjacketing or other insulation, for maintaining the specified temperature of the bituminous material in the lines, meters, weigh buckets, spray bars, and other containers or flow lines.

Thermometers of approved type and adequate range, calibrated in five degrees F. increments, shall be located at points readily visible. These thermometers shall be kept clean and in good condition at all times.

Where storage tanks are required, the capacity shall be sufficient for at least one day's run.

The heating of bituminous materials shall be rigidly maintained at the "lowest workable temperature."

702.04--Sampling. Sampling of bituminous materials shall be as set out in AASHTO Designation: T 40.

702.05--Petroleum Asphalt Cement. Asphalt cement shall be homogeneous, free of water and shall not foam when heated to a temperature of 175°C. Except for use in hot mix asphalt, asphalt cement of the grade specified shall conform to the requirements of Subsection 702.12, Table I or II.

Bituminous material conforming to AASHTO Designation: M 320, Grade PG 58-28 may be used in lieu of petroleum asphalt cement, Grade AC-10.

The bituminous material used in all types of hot mix asphalt shall conform to AASHTO Designation: M 320, Performance Grade PG 67-22, as modified in the table below, except when otherwise specified or when polymer modified hot mix asphalt is specified.

Specifications For Performance Graded Asphalt Binders Not Addressed By AASHTO M 320		
	Grade	
Property	PG 67-22	
	Specification	Test Method, AASHTO
Original Binder		
Flash Point Temperature	minimum 230°C	T 48
Rotational Viscosity	maximum 3 Pa•s @ 135°C	T 316
Dynamic Shear, $G^*/\sin \delta$	minimum 1.00 kPa @ 67°C	T 315
Rolling Thin Film Oven Residue (AASHTO Designation: T 240)		
Mass Loss (RTFO)	maximum 1.00 %	T 240
Dynamic Shear, $G^*/\sin \delta$	minimum 2.20 kPa @ 67°C	T 315
Pressure Aging Vessel Residue (AASHTO Designation: R 28)		
Dynamic Shear, $G^*\sin \delta$	maximum 5000 kPa @ 26.5°C	T 315
Creep Stiffness, S	maximum 300 MPa @ -12°C	T 313
m-value	minimum 0.300 @ -12°C	T 313

The bituminous material used in polymer modified hot mix asphalt shall conform to AASHTO Designation: M 320, Grade PG 76-22 or PG 82-22. Unless otherwise indicated in the contract, Grade PG 76-22 will be used in polymer modified hot mix asphalt.

Asphalt cement Grade PG 76-22 & PG 82-22 shall be the product resulting from the addition of a polymer modifier to a PG 67-22 or lower grade asphalt cement and not by some other refining technique. The polymer shall meet the requirements of Subsection 702.08.3.

702.06--Cutback Asphalts. Cutback asphalt shall consist of a liquid asphalt produced by the fluxing of an asphaltic base with a suitable distillate. It shall be of uniform consistency, free of water, and shall show no separation or curdling prior to use; and shall conform to the following requirements.

702.06.1--Rapid-Curing Cutback Asphalt: AASHTO Designation: M 81.

702.06.2--Medium-Curing Cutback Asphalt: AASHTO Designation: M 82.

The standard naphtha solvent shall be used when the spot test is performed.

702.07--Emulsified Asphalt. Emulsified asphalt shall be homogeneous, showing no separation of asphalt, limits for settlement excepted, after thorough mixing, within 30 days after delivery.

Emulsified asphalts which have been subjected to freezing temperatures while in storage shall be retested and acceptance of the material shall be based on the results of such retest.

Emulsified asphalts, of the grade specified, shall conform to the following requirements:

702.07.1--Emulsified Primes. Emulsified Primes shall conform to the requirements of Subsection 702.12, Table III.

702.07.2--Anionic and Cationic. Anionic and Cationic Emulsion shall conform to the requirements of AASHTO Designation: M 140 and AASHTO Designation: M 208, respectively, with the following exceptions.

Exception: The required tests on residue may be performed on residue obtained by evaporation at 325°F., three hours, 50 grams, after filtering through a No. 50 sieve; however, in the event of the failure of any test performed on this residue, the emulsion shall be distilled and the test repeated on the residue so obtained.

702.07.3--Polymer Modified Cationic Emulsified Asphalt (CRS-2P). Polymer Modified Cationic Emulsified Asphalt shall conform to the requirements of AASHTO Designation: M 316.

702.08--Asphalt Additives.

702.08.1--Asphalt Antistrip Additives. The antistrip additive shall meet the following properties:

The bituminous mixture with antistrip additive, when tested in accordance with Mississippi Test Method MT-63, shall yield a minimum Tensile Strength Ratio (TSR) of 85 and must show an increase in indirect tensile strength for a water conditioned specimen; and by visual examination of the interior faces of the water conditioned specimen, the proportion of stripped aggregate particles shall not exceed five percent.

The rate of application shall be determined for each job-mix formula during the mix design process using Mississippi Test Method MT-63.

A stripping test, MT-63, will be performed for each job-mix formula at the beginning of plant production and thereafter, no less than one test per two week's production. A minimum of one stripping test per day of production according to Mississippi Test Method MT-59 shall also be conducted.

Should either the TSR (MT-63) or the boiling water (MT-59) stripping test fail, a new antistrip rate shall be established or other changes made immediately that will result in a mixture which conforms to the specifications; otherwise, production shall be suspended until corrections are made.

The antistrip additive shall not present any difficulties in mixing of the liquid asphalt with the particular aggregates proposed for use.

The liquid asphalt and antistrip agent mixture shall meet the viscosity requirements for the grade of liquid asphalt used in the paving mix.

702.08.2--Silicone. When specified or permitted, silicone with a viscosity of 1,000 centistokes at 77°F shall be added to the asphalt cement at the rate of one ounce per 5,000 gallons.

702.08.3--Polymers. The polymer shall be a Styrene Butadiene Styrene (SBS), a Styrene Butadiene Rubber (SBR) or an equal approved by the Engineer. The polymer shall be thoroughly blended with the asphalt cement at the refinery or terminal prior to shipment to the hot-mix plant. Producers of polymer modified asphalt cement must be listed on MDOT's Approved List of Suppliers of Polymer Modified Asphalt Cement. The producer of the polymer modified asphalt cement shall perform or have performed by an approved laboratory all tests contained in AASHTO Designation: M 320 on a lot basis. A lot shall consist of one (1) refinery or terminal storage tank not to exceed 225,000 gallons. The Producer shall furnish two copies of a certified test report (one copy for the Contractor and one copy for the Department Representative) with each shipment. A third copy of the certified test report shall be mailed to the State Materials Engineer. The certified test report shall contain the following:

- (1) Test results showing complete conformance to AASHTO Designation: M 320
- (2) Type and percentage of polymer added
- (3) A statement certifying that the transport vehicle was inspected prior to loading and was found to be empty
- (4) A statement certifying that the shipment conforms to Mississippi Department of Transportation specifications for the grade of polymer modified asphalt cement specified
- (5) A copy of the temperature-viscosity curve attached to the certified test report.

Crumb rubber used as a polymer modifier shall meet the following additional requirements:

Crumb rubber shall be produced by ambient grinding methods. The rubber shall

be sufficiently dry so as to be free flowing and to prevent foaming when mixed with asphalt cement. The rubber shall be free of contaminants including fabric, metal, minerals and other non-rubber substances. Up to four percent, by weight of rubber, of talc, such as magnesium silicate or calcium carbonate, may be added to prevent sticking and caking of the particles.

The crumb rubber shall be tested in accordance with AASHTO Designation: T 27 with the following exceptions: a 100-gram sample size and up to 25% dusting agent (talc). Rubber balls may also be used to aid in the sieving of finely ground rubber. The resulting rubber gradation shall meet the gradation limits shown herein.

<u>Gradations of Crumb Rubber</u>	
Type A	
<u>Sieve Size</u>	<u>% Passing</u>
10	--
20	--
30	--
40	100
60	98-100
80	90-100
100	70-90
200	35-60

The specific gravity of the rubber shall be 1.15 ± 0.05 when tested in accordance with ASTM Designation: D 297, pycnometer method.

The moisture content shall be determined in accordance with AASHTO Designation: T 255, with the exception that the oven temperature shall be $140 \pm 5^{\circ}\text{F}$ and the weight of the sample shall be 50 grams. The moisture content shall not exceed 0.75% by weight.

No more than 0.01% metal particles shall be detected when thoroughly passing a magnet through a 50-gram sample.

The chemical composition of the crumb rubber shall be determined in accordance with ASTM Designation: D 297 and shall meet the following requirements:

Acetone Extract	Maximum 25 percent
Rubber Hydrocarbon Content	40 to 55 percent
Ash Content	Maximum 10 percent
Carbon Black Content	20 to 40 percent
Natural Rubber	16 to 34 percent

Crumb rubber meeting these specifications shall be supplied in moisture resistant packaging such as either disposal bags or other appropriate bulk containers.

Each container or bag of crumb rubber shall be labeled with the manufacturer's designation for the rubber and the specific type, maximum nominal size, weight and manufacturer's batch or lot designation.

The producer of the polymer modified asphalt cement shall furnish the State Materials Engineer one copy of the manufacturer's certified test results covering each shipment of crumb rubber. These reports shall indicate the results of tests required by this specification. The reports shall also include a certification that the material conforms with the specifications, and shall be identified by manufacturer's batch or lot number.

702.09--Blank.

702.10--Primer For Use With Asphalt For Dampproofing and Waterproofing. Primer for use with asphalt shall meet the requirements of the Standard Specifications for Primer for Use with Asphalt in Dampproofing and Waterproofing, AASHTO Designation: M 116.

702.11--Application Temperatures. Bituminous materials for the several applications indicated in the specifications shall be applied within the temperature ranges shown in 702.12, Table IV.

702.12--Tables.

TABLE I
SPECIFICATIONS FOR ASPHALT CEMENT (PETROLEUM)

TEST	*AC-5		AC-10		**AC-13	
	Min.	Max.	Min.	Max	Min.	Max.
Viscosity @ 140°F, poises	400	600	800	1200		
Viscosity @ 275°F, C _s	175	--	240	--		
Penetration @ 32°F					25	
Penetration @ 77°F, 100g, 5 sec.	140	--	80	--	65	90
Penetration @ 115°F						325
Flash Point COC, °F	400	--	425	--	450	--
Solubility in Trichloroethylene	99.0	--	99.0	--	99.0	--
Tests on Residue from Thin-Film Oven Test:						
Viscosity, 140°F, poises	--	2250	--	4500		
Ductility, 77°F, 5 cm per min., cm.	100	--	100	--	75	--
% Loss on Heating	--	1.0	--	0.5	--	0.5
Specific Gravity @ 60°F/60°F					1.00	
Spot Test: Standard Naphtha Solvent		Negative for all Grades***				
Softening Point, °F (R & B)					110	

NOTES: * When cut-back asphalt cement is to be produced as specified in Subsection 702.06, this material shall be the base asphalt.

 ** This is an asphaltic material used primarily for sealing joints and cracks.

 *** If positive, the test must be rerun with a solution of 75% naphtha and 25% xylene.

TABLE II
SPECIFICATIONS FOR ASPHALT CEMENT (PETROLEUM)
(Continued)

TEST	AC-20		AC-30		AC-40	
	Min.	Max	Min.	Max	Min.	Max
Viscosity @ 140°F (60°C), poises	1600	2400	2400	3600	3200	--
Viscosity @ 275°F (135°C), C _s	300	--	350	--	350	
Penetration @ 32°F (0°C)						--
Penetration @ 77°F (25°C) 100g, 5 sec.	60	--	50	--	40	--
Penetration @ 115°F (46°C)						
Flash Point COC, °F	450	--	450	--	450	--
Solubility in Trichloroethylene	99.0	--	99.0	--	99.0	--
Tests on Residue from Thin-Film Oven Test:						
Viscosity, 140°F (60°C), poises	--	9000	--	13500	--	18000
Ductility, 77°F (25°C), 5 cm / min., cm.	80	--	60	--	40	--
% Loss on Heating	--	0.5	--	0.5	--	0.5
Specific Gravity @ 60°F/60°F						
Spot Test: Standard Naphtha Solvent		Negative for all Grades*				
Softening Point, °F (R & B)						

NOTES: * If positive, the test must be rerun with a solution of 75% naphtha and 25% xylene.

TABLE III
SPECIFICATION FOR EA-1 PRIME

Test Requirements	Minimum	Maximum
Furol Viscosity @ 122°F	30	100
Water Content Xylene Distillation, %	3	8
Test on Residue from Distillation		
Ductility @ 77°F, cms.	40	
Solubility in Trichloroethylene, %	97.0	
Asphalt Cement, % of Total Primer	50.0	
Penetration @ 77°F, 100 g., 5 sec.	80	300

SPECIFICATION FOR AE-P PRIME

Test Requirements	Min.	Max.	AASHTO Test Method
25°C SFS Viscosity, sec.	10	50	T-59
5-Day Settlement, %	--	5	T-59
Total Distillate, % weight	--	55	T-59
Oil Distillate, % volume	--	12	T-59
Tests on Residue from Distillation: Distillation to 500°F (AASHTO T-59)			
60°C Float Test, sec.	20	--	T-50
Solubility in TCE, %	97.5	--	T-44

TABLE IV
WORKING TEMPERATURES FOR BITUMINOUS MATERIALS

Bituminous Materials	Temperature, °F			
	Spraying		Mixing	
	Min.	Max.	Min.	Max.
Asphalt All Cements	275	350	225	350
Cutback Asphalts RC & MC				
30	80	150	60	105
70	80	150	95	140
250	100	200	135	175
800	195	270	165	205
3000	235	300	200	240

SECTION 703 - AGGREGATES

703.01--General. All aggregate sources shall be approved by the Department prior to use. All approved aggregate sources will be re-examined periodically for conformance to the quality requirements set herein.

When reference is made to the Los Angeles Test (AASHTO Designation: T 96), the percentage of wear is based on 500 revolutions, unless otherwise specified.

The term "thin or elongated piece" is intended to mean a piece whose length is more than five times its average thickness. Suspected pieces will be chosen from a representative sample, and the length and average thickness will be determined visually.

The term "fractured face" is intended to mean that the approximate area of a fractured face shall not be less than the approximate cross-sectional area at the minor axis of the particle. This area will be visually determined. A piece of aggregate with a small chipped area will not be considered as crushed.

All concrete produced for use in Department work shall be manufactured from aggregates which have been tested and accepted by Department personnel.

These general provisions shall apply, as applicable, to all the subsections of this section.

703.02--Fine Aggregate For Portland Cement Concrete.

703.02.1--General Requirements. Fine aggregate for portland cement concrete used in construction of culverts, headwalls, retaining walls, steps, or other minor structures shall consist of natural sand or manufactured limestone sand. Fine aggregate used in major construction, such as concrete pavements and bridges, shall be natural sand unless otherwise designated on the plans or in the special provisions. Natural sand, or manufactured limestone sand, shall be composed of clean, hard, durable, and uncoated particles free of deleterious substances and organic impurities. Fine aggregate from more than one source shall not be used alternately, or mixed, without the written consent of the Engineer. Approval of fine aggregate sources will be based on the following:

Soundness of aggregate shall meet the requirements set out in Subsection 703.02.2.3.

Expansion of mortar bars shall not exceed 0.5% in six months or 1.0% in one year when tested in accordance with ASTM Designation: C 227.

A source of sand may be rejected if experience proves that concrete made from the source does not have a satisfactory service record. Unless indicated

otherwise, fine aggregate shall meet the requirements hereinafter specified.

703.02.2--Detail Requirements.

703.02.2.1--Deleterious Substances. The quantity of deleterious substances shall not exceed the following limits:

<u>Deleterious Substances</u>	<u>Maximum Permissible Limits (% by Weight)</u>
Clay lumps	0.3
Coal and lignite (see Note)	0.5
Material Passing the No. 200 Sieve	2.0
Other deleterious substances such as shale, alkali, mica, coated grains, and soft and flaky particles	2.0
Total shale, coal, lignite, clay lumps, and other deleterious substances	3.0

Note: No coal or lignite will be permitted in the aggregate used for constructing superstructures of bridges.

703.02.2.2--Gradation Requirements. Fine aggregate for concrete shall be well graded from coarse to fine and shall conform to the following:

Square Mesh Sieve	Percent Passing by Weight
1/2 inch	100
3/8 inch	97 - 100
No. 4	92 - 100
No. 8	75 - 100
No. 16	45 - 90
No. 30	25 - 70
No. 50	3 - 35
No. 100	0 - 10

The gradation of material from any one source shall be reasonably uniform and not subject to the extreme gradation shown above. The degree of uniformity will be determined by fineness modulus determination from representative samples submitted from the sources the Contractor proposes to use. Fine aggregate from any one source having a variation in fineness modulus greater than 0.20 from the approved base modulus of the source may be rejected or may be accepted subject to changes in the proportions, if and as directed by the Engineer.

When the slip-form method for placement of concrete pavement is used, the fine

aggregate gradation requirements will be modified if necessary.

703.02.2.3--Soundness. When subjected to five cycles of soundness test by the use of magnesium sulfate, AASHTO Designation: T 104, the weighted percentage of loss shall not be more than 15.

703.02.2.4--Additional Requirements. Fine aggregate shall also meet the organic impurities and mortar-making properties specified in AASHTO Designation: M 6.

703.03--Coarse Aggregate For Portland Cement Concrete.

703.03.1--General Requirements. Coarse aggregate shall consist of gravel or crushed limestone unless otherwise designated or permitted on the plans or in special provisions.

The gravel or crushed limestone shall be hard, durable particles that are thoroughly clean, free from adherent coatings of injurious character, and reasonably free of soft or disintegrated pieces, frozen lumps, vegetable, or other deleterious matter. Coarse aggregate from more than one source shall not be used alternately, or mixed, without the written approval of the Engineer. Approval of coarse aggregate sources will be based on the following:

Soundness of aggregate shall meet the requirements set out in Subsection 703.03.2.3.

Resistance to abrasion shall meet the requirements set out in Subsection 703.03.2.2.

Expansion of mortar bars shall not exceed 0.5% in six months or 1.0% in one year when tested in accordance with ASTM Designation: C 227.

A source of coarse aggregate may be rejected if experience proves that concrete made from the source does not have a satisfactory service record.

703.03.2--Detail Requirements.

703.03.2.1--Deleterious Substances. The quantity of deleterious substances shall not exceed the following limits:

Deleterious Substance	For General Use	For Bridge Superstructures
	Percent by Weight	
Shale	1.00	1.00
Coal, lignite, or combination of the two	0.5	None
Clay lumps	0.3	0.3
Material passing the No. 200 sieve:		
Limestone	1.5	1.5
Other Materials	1.0	1.0
Thin or elongated pieces as referenced in Subsection 703.01	15.0	15.0
Soft fragments	3.0	3.0
Free shells	1.0	1.0
Sticks, oven-dry	None	None
Shale, coal, lignite, clay lumps, and soft fragments, total	3.0	2.5
Other deleterious substances	1.0	1.0

703.03.2.2--Percentage of Wear. When coarse aggregate is subjected to the Test for Abrasion of Coarse Aggregate, AASHTO Designation: T 96, the percentage of wear shall not be more than 40.

703.03.2.3--Soundness. When subjected to five cycles of soundness test by the use of magnesium sulfate, the weighted percentage of loss shall not be more than 15.

703.03.2.4--Gradation. Coarse aggregate for cement concrete, of the type designated, shall be well-graded from coarse to fine, and shall conform to the following:

**Table of Sizes and Gradation of Coarse Aggregate
for Portland Cement Concrete**

Square Mesh Sieves	Percent Passing by Weight			
	Size No. 467	Size No. 57	Size No. 67	Size No. 7
2 inch	100			
1 1/2 inch	95-100	100		
1 1/4 inch				
1 inch		80-100	100	
3/4 inch	35-70		80-100	100
1/2 inch		25-60		90-100
3/8 inch	10-30		20-55	40-70
No. 4	0-5	0-10	0-10	0-15
No. 8		0-5	0-5	0-5

NOTE: A maximum tolerance of three percent retained on the one-inch sieve will be allowed for aggregate Size No. 67 provided all of the material passes a one and one-fourth-inch sieve. This tolerance is not applicable for Class F and Class FX Concrete.

The gradation from any one source shall be reasonably uniform and not subject to the extreme limits of gradation shown in the table.

For the purpose of determining the degree of uniformity, a fineness modulus determination will be made upon representative samples from the sources proposed for use by the Contractor. Coarse aggregate from any one source, having a variation in fineness modulus greater than 0.20 from the approved base modulus of the source may be rejected or may be accepted subject to changes in the proportions used, as directed.

703.04--Aggregate for Crushed Stone Courses.

703.04.1--Coarse Aggregate. Coarse aggregate, defined as material retained on No. 8 sieve, shall be either crushed stone, slag, granite, shell; gravel, or combination thereof. When the required properties of the mix are not obtained with uncrushed gravel, the addition of crushed gravel or other approved material is required.

Individual sources of coarse aggregate shall conform to the following quality requirements:

Percentage of wear shall not exceed 45 when tested in accordance with AASHTO Designation: T 96.

The coarse aggregate shall have a minimum dry rodded unit weight of 70 pounds per cubic foot when tested in accordance with AASHTO Designation: T 19.

703.04.2--Fine Aggregate. Fine aggregate, defined as material passing no. 8 sieve, shall consist of hard, durable particles of naturally disintegrated rock, or material obtained by crushing stone, slag, gravel or combination thereof. Fine aggregate, when manufactured, shall be manufactured from material meeting the quality requirements for coarse aggregate, and it shall be free of lumps of clay and friable particles, loam, organic or foreign matter.

Individual sources of fine aggregate shall be non-plastic when tested in accordance with AASHTO Designation: T 90.

Natural deposits of fine aggregate shall contain no more than 10 percent by weight passing the No. 200 sieve when tested in accordance with AASHTO Designation: T 11.

Fly ash, when used as a portion of the fine aggregate to obtain desired properties of the mixture, shall be from an approved source.

When the fine aggregate is combined with other aggregate fractions in the proper proportion, the resultant mixture shall meet the requirements of Subsection 703.11 and the job-mix formula

703.04.3--Gradation. Aggregates for crushed stone shall be well-graded from coarse to fine, and shall conform to the following:

**TABLE OF SIZES AND GRADATION OF CRUSHED STONE
AGGREGATE**

Sieve Size	Percent Passing by Weight		
	Size ¾ inch and Down	Size No. 610	Size No. 825 B
2 inch			100
1 1/2 inch		100	90 - 100
1 inch	100	90 - 100	75 - 98
3/4 inch		70 - 100	
1/2 inch		62 - 90	60 - 85
3/8 inch	50 - 85	50 - 80	
No. 4	35 - 65	40 - 65	40 - 70
No. 8			28 - 54
No. 10	25 - 50		
No. 16			19 - 42
No. 40	15 - 30	12 - 26	
No. 50			9 - 32
No. 200	5 - 15	5 - 12	4 - 18

703.05--Blank.

703.06--Aggregates for Hot Mix Asphalt.

703.06.1--Coarse Aggregates. Coarse aggregate, material retained on the No. 8 sieve, shall be either crushed stone, slag, or granite; shell; expanded clay; expanded shale; crushed gravel or combination thereof. Crushed reclaimed concrete pavement shall also be allowed as a coarse aggregate provided it meets the quality requirements below and the final product produced therefrom meets all other specification requirements.

The percentage of wear shall not exceed 45 when tested in accordance with AASHTO Designation: T 96.

When tested in accordance with AASHTO Designation: T 19, the dry rodded unit weight of all aggregates except expanded clay and shale shall not be less than 70 pounds per cubic foot, and crushed slag used in the surface course shall have a dry rodded unit weight of not more than 90 pounds per cubic foot except the maximum unit weight is waived for chromium slag.

The coarse aggregate shall be free of any injurious coating which will prohibit the adherence of asphalt to the aggregate particles.

The percentage of loss shall not exceed 20 when tested for soundness using

magnesium sulfate in accordance with AASHTO T 104.

Shell shall consist of durable, washed particles of dead clam or dead reef oyster shell, or combination thereof. The shell shall be free of objectionable matter such as sticks, mud, clay lumps, cannery or live shell, or other deleterious matter. Not more than five percent by weight of the dredged material shall pass the No. 200 sieve; any such material shall be dispersed throughout the mass.

703.06.1.2--Fine Aggregates. Fine aggregate, material passing the No. 8 sieve, shall consist of hard, durable particles of naturally disintegrated rock, or material obtained by crushing stone, slag, gravel, reclaimed concrete pavement, or combinations thereof. Fine aggregate produce from crushing reclaimed concrete pavement shall be manufactured from material meeting the quality requirements for coarse aggregate.

Fine aggregate shall be free of lumps of clay and friable particles, loam, organic or foreign matter.

Fine aggregate produced by crushing stone, slag or gravel shall be manufactured from aggregate meeting the quality requirements of coarse aggregate.

Individual sources of fine aggregate shall be non-plastic when tested in accordance with AASHTO Designation: T 90.

Natural deposits of fine aggregate shall contain no more than 10 percent by weight passing the No. 200 sieve when tested in accordance with AASHTO Designation: T 11.

Individual fine aggregate components shall be of such consistency and dryness that a uniform and even flow from the cold feed will be provided.

Fly ash shall not be used in hot mix asphalt pavements.

703.07--Granular Materials.

703.07.1--General. Granular materials shall be composed of a natural or manufactured mixture of soil binder and sand; soil binder, sand and gravel; stone; slag; or combinations thereof. The mixture shall have satisfactory cementing qualities and shall be homogeneous in character and reasonably free of clay balls, vegetable matter, or other deleterious substances that cannot be classed as serviceable.

To insure adequate soil drainage through the shoulders, no material used above the design soil in the construction of shoulders shall have a minus 200 sieve fraction, liquid limit, or plasticity index appreciably exceeding like characteristics in the adjacent base courses.

703.07.1.1--Fine Aggregate (Portion Passing The No. 10 Sieve). The fine aggregate shall be composed of a natural or artificial mixture of soil binder and granular material. The soil binder shall be clay or silt or other materials, or combinations thereof having satisfactory cementing qualities, homogeneous in character, and reasonably free of vegetable matter, clay balls, or other deleterious substances that cannot be classed as serviceable. The granular portion shall be composed of sand, stone, or slag screenings and shall be hard and durable and preferably sharp.

703.07.1.2--Coarse Aggregate (Portion Retained on the No. 10 Sieve). The coarse aggregate shall be composed of gravel, stone, slag, or combinations thereof, and shall consist of hard, durable particles reasonably free of vegetable matter or other deleterious substances. Materials that break up and weather rapidly when alternately frozen and thawed or wetted and dried shall not be used.

Coarse aggregate, when tested in accordance with AASHTO Designation: T 96, shall have a percentage of wear not to exceed 50.

703.07.2--Gradation. The gradations shown in the following tables are the maxima and minima for all sources, and the gradation from any one source shall be reasonably uniform and not subject to the extreme limits in the tables. It shall be the responsibility of the Contractor to furnish a material which will have sufficient silt and clay, within the ranges permitted in the tables, to insure that the material will, when processed as specified, bind together and form a stable course and will, when properly compacted, have the required density.

The gradation of the class specified shall meet the applicable requirements of the following table:

Percentage By Weight Passing Square Mesh Sieves

Sieve Size	Class						
	1 & 2	3 & 4	5 & 6	7	8	9	10
3"	100	100	100	100	100	100	100
1 1/2"	85 - 100	85 - 100	85 - 100				
1"	65 - 100	65 - 100	65 - 100				
1/2"	35 - 90	35 - 90	35 - 100				
No. 4	30 - 70	30 - 75	30 - 85				
No. 10	30 - 50	30 - 57	30 - 65	30 - 10	30 - 100	30 - 100	30 - 100

Note: The minimum percentage passing the No. 10 sieve may be lowered to 25% by the Engineer if proper placement characteristics and stability can be obtained by the coarser gradation.

Material Passing the No. 10 Sieve

Sieve Size	Class									
	1	2	3	4	5	6	7	8	9	10
No. 10	100	100	100	100	100	100	100	100	100	100
No. 40	20 - 80	20 - 90	20 - 90	20 - 90	20 - 100	20 - 100	40 - 80	20 - 85	20 - 100	20 - 100
No. 60	15 - 70	15 - 80	15 - 80	15 - 80	15 - 80	15 - 80	30 - 70	15 - 70	15 - 85	15 - 100
No. 200	8 - 40	6 - 40	8 - 40	6 - 40	8 - 40	6 - 40	10 - 40	8 - 40	6 - 40	8 - 60

Material Passing the No. 40 Sieve shall meet the following:

Group Symbol	LL Max.	PI	
		Min.	Max.
A	25		6
B	25		8
C	30		10
**D	35		15
**E	35	6	15

General Note: Material will be designated in the contract by Class _____,
Group _____.

** In the case of Group D material, the range of PI shall be no more than nine in any half-mile section. When Group E material is specified in the contract, that portion to be treated with cement may be less plastic or non-plastic except that the range in PI shall be no more than nine in any half-mile section.

703.07.3--Sampling and Testing. The material shall be sampled and tested as outlined in Subsection 700.03.

703.08--Mechanically Stabilized Courses. Specified aggregates meeting the requirements of Subsection 703.20 when combined with soils or other aggregates as required will be tested for gradation and plasticity of the composite mixture.

In the case of gravel, stone, or slag aggregates or combinations thereof, the composite mixture will be designated in the contract as Type A, Type B, or Type C. In the case of reef shell or clam shell aggregates or combinations thereof, the composite mixture will be designated in the contract as Type D.

The composite mechanically stabilized mixture of the type and group specified in the contract shall meet the following requirements:

Percentage By Weight Passing Square Mesh Sieves

Sieve Size	Type			
	A	B	C	D
3"	100	100	100	95-100
1 1/2"	85-100	85-100	85-100	
1"	65-100	65-100	65-100	
1/2"	35-90	35-90	35-100	
No. 4	30-70	30-75	30-85	
No. 10	30-50	30-57	30-65	55(Max.)
No. 40				

Material passing the No. 40 sieve shall meet the following:

Group Symbol	LL Max.	PI	
		Min.	Max.
A	25		6
B	25		8
C	30		10
**D	35		15
**E	35	6	15

Note: Desired product will be designated in the contract as Type _____,
Group _____.

703.09--Blank.

703.10--Blank.

703.11--Blank.

703.12--Blank.

703.13--Aggregate for Cold Bituminous Pavement. The fine and coarse aggregate fractions for the mixture shall be so sized and graded that when combined the resultant mixture will be uniformly graded from coarse to fine and meet the applicable requirements of the gradation table.

703.13.1--Coarse Aggregate. The coarse aggregate shall be crushed slag, crushed limestone, crushed gravel, expanded clay, granite, crushed reef shell or a combination thereof and shall meet the quality requirements of Subsection 703.09.

Crushed processed reef shell shall consist of dead oyster shell, dead clam shell, or combinations thereof. It shall not contain cannery or live shell. The uncrushed shell shall be produced or processed by washing over a screen washer. The mesh of the screen washer shall not be smaller than 1/4 inch. Before crushing, material passing the No. 200 sieve shall not exceed four percent.

703.13.2--Fine Aggregate. Fine aggregate shall meet the quality requirements of Subsection 703.09. When crushed limestone or crushed reef shell is used as the coarse aggregate, at least 60% of the fine aggregate portion of the mixture shall consist of naturally disintegrated rock.

703.13.3--Aggregate for Top Dressing. Material for top dressing shall consist of dry sand, gravel screenings, stone screenings or slag screenings and conform to the following gradation requirements:

<u>Square Mesh</u> <u>Sieve</u>	<u>Percent Passing</u> <u>By Dry Weight)</u>
3/8 inch	100
No. 4	95 (min.)
No. 50	30 (max.)
No. 100	5 (max.)

GRADATION REQUIREMENTS COLD BITUMINOUS PAVEMENTS

Type:	Binder	Binder	Binder	Surface	Surface	Surface	Surface
Designation:	A	B	C	D	E	F	G
Sieve:	(Percent Passing by Weight, Aggregate Only)						
1 1/2 inch	100						
1 1/4 inch	90-100						
1 inch		100					
3/4 inch		90-100	100		100		
5/8 inch	30-60				90-100		
1/2 inch		40-85	80-100	100		100	100
3/8 inch			60-90	90-100		95-100	90-100
No. 4	5-25	10-35	45-75	60-98	10-40	40-70	
No. 10	0-15	5-20	35-60	35-70	5-30	15-50	50-90
No. 40	0-5	0-12	12-30	14-35	1-20	5-30	20-55
No. 80			4-20	3-15	0-15	1-20	7-30
No. 200	0-2	0-6	1-10	0-5	0-5	0-10	2-12
% A.C. by Weight of							
Total Mix	3.5-5.5	4.0-7.0	5.0-8.0	5.0-8.0	4.5-6.5	4.5-8.5	5.8-8.5*
Liquefier**	Max.2.0	Max.2.0	Max.2.0	Max.2.0	Max.2.0	Max.2.0	Max.2.0
Hydrated Lime***	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.5

* These limits include the natural asphalt recoverable by extraction in natural asphaltic limestone, and aggregate gradation limits include sand added in accordance with Subsection 703.13.2.

** Liquefier shall be commercial grade Naptha or Kerosene.

*** Hydrated lime, for facilitator, shall meet Subsection 714.03.

RANGE OF TOLERANCES

Passing No. 10 and larger sieves-----	± 10%
Passing Nos. 40 and 80 sieves-----	± 7%
Passing No. 200 sieve -----	± 3%
Percent Asphalt Cement-----	± 0.5%
Percent Liquefier-----	± 0.5%

703.14--Aggregate for Bituminous Surface Treatments.

703.14.1--General Requirements. Aggregate for bituminous surface treatments and liquid seals shall consist of crushed stone, crushed slag, gravel, or expanded clay as specified in the contract.

Only one kind and type of aggregate shall be used on a single course unless otherwise authorized by the Engineer in writing.

703.14.2--Detail Requirements.

703.14.2.1--Gradation. Aggregates shall conform to the gradation requirements contained in the following table:

GRADATION REQUIREMENTS FOR COVER AGGREGATE

Square Mesh Sieve	Coarse Aggregate Cover Material			Seal Aggregate Cover Material			
	Slag, Stone, Granite or Gravel (Crushed or Uncrushed)			Slag, Stone, Granite or Crushed Gravel		Slag or Expanded Clay	
	Size No. 5	Size No. 56	Size No. 6	Size No. 7	Size No. 89	Size No. 7	Size No. 8
Percent Passing Square Opening Sieves							
1 1/2 inch	100	100					
1 inch	90-100	90-100	100				
3/4 inch	20-55	40-85	90-100	100		100	
1/2 inch	0-10	10-40	20-55	90-100	100	90-100	100
3/8 inch	0-5	0-15	0-15	40-85	90-100	40-85	85-100
No. 4		0-5	0-5	0-15	20-55	0-15	10-30
No. 8				0-5	5-30	0-5	0-10
No.16					0-10	0-5	0-5

The size coarse aggregate cover material and the size seal aggregate cover material shall be as specified in the bid schedule of the contract; however, only one kind of aggregate shall be used unless otherwise authorized by the Engineer in writing.

703.14.2.2--All Materials. The quantity of deleterious substances shall not exceed the limits set out in Subsection 703.03.2.1 for general use.

When subjected to five cycles of Soundness Test for Coarse Aggregate by use of magnesium sulfate, the weighted percentage of loss shall not be more than 15.

The percentage of wear, when tested for abrasion in accordance with AASHTO Designation: T 96, shall not be more than 40%.

703.14.2.3--Crushed Stone. Crushed stone shall consist of clean, tough, durable, uncoated fragments free from an excess of soft or disintegrated pieces.

703.14.2.4--Crushed Slag. Crushed slag shall be air-cooled slag consisting of angular fragments, reasonably uniform in density and quality, and reasonably free of dirt or other objectionable matter. Crushed slag shall have a dry-rodded weight of 70 to 90 pounds per cubic foot when tested in accordance with AASHTO Designation: T 19 and shall not contain more than 10 percent by weight of glassy particles. The maximum unit weight is waived for chromium slag.

703.14.2.5--Crushed Gravel. Crushed gravel shall be composed of clean, tough, durable particles of gravel, free from excess dirt or other objectionable matter. At least 85% by weight of the particles retained on the No. 10 sieve shall have one or more fractured faces.

703.14.2.6--Uncrushed Gravel. Uncrushed gravel shall be composed of clean, tough, durable particles free from excess vegetable or other objectionable matter. It shall meet the requirements specified above for all materials as to deleterious substances.

703.14.2.7--Expanded Clay. Expanded clay aggregate shall be the product of a plant approved by the Engineer. It shall conform to the gradation requirements in the preceding table and to requirements of ASTM Designation: C 330, with the following exception: The loss by abrasion shall not be more than 40% when subjected to the Los Angeles Abrasion Test, AASHTO Designation: T 96.

When used for sealing joints as specified in Section 413, the soundness and abrasion requirements will be waived.

703.15--Blank.

703.16--Mineral Filler. Mineral filler shall consist of shell dust, limestone dust, portland cement, or other calcareous type materials having a high affinity for asphalt. The source of the material shall be approved by the Engineer.

Mineral filler shall meet the following gradation requirements:

Passing the No. 30 sieve, %-----	100
Passing the No. 50 sieve, not less than, % -----	95
Passing the No. 200 sieve, not less than, %-----	65

703.17--Blank.

703.18--Mortar Sand. Sand for mortar shall consist of hard, strong, durable, uncoated mineral or rock particles, free of injurious amounts of organic or other deleterious substances. It shall not contain, by weight, more than three percent clay or inorganic silt or combination thereof.

Mortar sand shall be uniformly graded from coarse to fine within the following limits:

<u>Sieve Size</u>	<u>% Passing</u>
No. 4	100
No. 8	97-100
No. 50	8-40
No. 100	0-10
No. 200	0-5

Mortar sand shall meet other requirements of AASHTO Designation: M 45.

703.19--Lightweight Aggregate for Structural Concrete. Lightweight aggregates for structural concrete shall meet the requirements of AASHTO Designation: M 195.

703.20--Aggregate for Stabilizer.

703.20.1--General Requirements. The material for stabilizer aggregate shall meet the requirements hereinafter specified for each type.

The gradation limits shown below are the maxima and minima for all cases, and a closer control appropriate to the job materials will be required for the specific project. Each type of aggregate shall be uniformly graded from coarse to fine. Skip-graded material will not be acceptable.

703.20.2--Detail Requirements.

703.20.2.1--Gravel, Stone, or Slag Coarse Stabilizer. Gravel or stone shall be composed of hard, tough, durable particles reasonably free of injurious or deleterious substances. The percentage of wear, when tested in accordance with AASHTO Designation: T 96, shall not exceed 50%.

Slag shall be air-cooled slag, consisting of angular fragments, reasonably uniform

in density and quality, and reasonably free of dirt or other objectionable matter. The weight per cubic foot shall be not less than 70 pounds. The percentage of wear, when tested in accordance with AASHTO Designation: T 96, shall not exceed 50%.

703.20.2.2--Shell. Shell shall consist of durable, washed particles of slaked clam or reef shell or combination thereof. The shell shall be free of objectionable matter such as sticks, mud, clay lumps, or other deleterious matter. Not more than four percent by weight of clay and sand will be permitted and such material shall be dispersed throughout the mass.

Clam shell shall consist of washed dead clam shell. Reef shell shall consist of washed dead oyster shell and shall not contain cannery or live shell.

703.20.2.3--Medium and Fine Stabilizer. Medium aggregate stabilizer and fine aggregate stabilizer shall consist of sand, stone, shell, and/or slag screenings.

Slag screenings, sand, or stone shall be composed of hard, durable particles reasonably free of injurious amounts of soft or flaky particles, dust lumps, organic, or other deleterious substances. Shell shall comply with the requirements set out in Subsection 703.20.2.2.

703.20.3--Gradation. The gradation of the various types of stabilizer shall be as follows:

PERCENT PASSING BY WEIGHT

Square Mesh Sieves	Shell	Coarse		Medium Fine	
		Gravel, Stone, or Slag		Gravel, Stone, Slag or Shell	
		Size I	Size II Note (1)		
2 1/2 inch	90-100				
2 inch		100			
1 1/2 inch		90-100	100		
1 inch		80-100	97-100		
3/4 inch		55-100	55-100		
1/2 inch		35-85	35-85	100	
3/8 inch		12-65	12-65	97-100	
No. 4, Note (2)		0-30	0-30	92-100	
No. 10		0-8	0-8	80-100	100
No. 40				10-40	80-100
No. 60	0-5			0-20	30-100
No. 100					15-80
No. 200		0-4	0-4	0-5	0-30
PI Material					
Passing No.40				6 or less	0

Note (1): Size II is intended for use in bases in which portland cement is used.

Note (2): Ground shell shall contain at least 97% passing the No. 4 sieve.

703.20.4--Stabilizer Aggregate, Local Materials. When local materials are designated for use as stabilizer aggregate, their requirements will be shown on the plans or in the special provisions.

703.21--Borrow Excavation. Borrow excavation shall be composed of a natural or manufactured mixture of sand, silt, and clay or combinations of sand, silt, clay, gravel or stone. The material shall have satisfactory cementing qualities, shall be reasonably free of vegetable matter or other deleterious substances that cannot be classed as serviceable, and shall be such that when properly compacted will form a dense mass. When rock or stone is used in the embankment, it shall be so graded and manipulated that the embankment will contain no appreciable interstices.

Borrow excavation from outside the right-of-way is divided into classes, each class conforming to the requirements set out in the following table:

BORROW EXCAVATION

		CLASS																
		B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17
Percent Passing	(Min.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	36	8
No. 200 Sieve	(Max.)	25	35	10	35	35	35	100	100	100	100	-	-	-	-	-	-	50
Percent Passing	(Min.)	-	-	-	-	-	-	-	-	-	-	8	8	8	8	-	-	-
No. 270 Sieve	(Max.)	-	-	-	-	-	-	-	-	-	-	100	70	100	100	-	-	-
Percent Silt	(Max.)	-	-	-	-	-	-	-	-	-	-	90	50	90	75	-	-	-
Fraction Passing																		
No. 40 Sieve -																		
Liquid Limit	(Max.)	-	40	-	45	40	45	40	55	40	55	45	40	55	45	-	40	40
Plasticity Index	(Max.)	6	10	np	10	20	25	10	10	20	-	25	20	35	25	35	-	12
	(Min.)	-	-	-	-	-	-	-	-	-	-	-	-	10	-	10	11	-
% Volume Change	(Max.)	-	-	-	-	-	-	-	-	-	-	-	-	60	-	50	50	-
Group Index	(Max.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-

The Class of material will be specified in the contract.

When the contract contains a numerical designation after the class number, it shall be understood to indicate the requirement that the material shall have a minimum PI of not less than that indicated by the numerical designation. For example, Class B9-6 requires Class B9 material having a minimum PI of 6; or a Class B9-10 requires Class B9 material having a minimum PI of 10, etc.

When a minimum PI is specified, the maximum plasticity index and the maximum liquid limit, as indicated in the table, will be raised the numerical designation for minimum PI, except that in the case of Class B8, Class B10 and Class B13 the maximum liquid limit shall remain as indicated in the table above.

For the design soil portion of the embankment all of the material shall pass a three-inch sieve. Individual contracts may further restrict the maximum size of material in the top portion of the design soil.

SECTION 704 - AGGREGATE FOR DRAINAGE

704.01--Permeable Material. Permeable material for use in backfilling trenches, under, around, and over underdrains and permeable material for blankets or other subdrainage purposes shall consist of hard, durable, clean sand, gravel, crushed stone, or crushed slag, and shall be free from organic material, clay balls, or other deleterious substances. These materials shall be as designated by Type as set out below.

704.02--Type A Filter Material. Type A filter material shall meet the requirements for Size 7 seal cover aggregate, or Size 7, 57, or 67 coarse aggregate for portland cement concrete, or Size II gravel coarse stabilizer as set out in Section 703. The crushing requirement for gravel seal cover aggregate is not applicable.

704.03--Type B Filter Material. Type B filter material shall be concrete sand conforming to the requirements of Subsection 703.02, except that the requirements for fineness modulus (FM) will not apply.

704.04--Type C Filter Material. Type C filter material shall consist of sand, stone, and/or slag screenings composed of hard, durable particles reasonably free of injurious amounts of soft or flaky particles, dust, lumps, organic, or other deleterious substances.

The gradation of the material shall be as follows:

<u>Sieve Size</u>	<u>Percent Passing</u>
1/2 inch	100
No. 4	80-100
No. 16	37-80
No. 50	5-30
No. 100	0-10

704.05--Type D Impervious Material. Type D impervious material shall consist of natural soil, soil aggregates, or a blend of natural soil and aggregates. The material shall be reasonably free of sticks, roots and other objectionable matter, shall be classified as Group A-6 or A-7, and shall conform with the following:

Percent passing No. 10 Sieve -----	80-100
Percent passing the No. 200 Sieve, minimum -----	36
Liquid Limit, maximum -----	50
Plasticity Index -----	12 to 25
pH-----	4.5 to 8.0

704.06--Crushed Stone Drainage Layers. The aggregate shall be crushed limestone, sandstone or granite conforming to the quality requirements of Subsections 703.01 and 703.03. The aggregate shall conform to the gradation set out below.

<u>Sieve Size</u>	<u>% Passing by Weight</u>
1 1/2"	100
1"	95 - 100
1/2"	60 - 82
No. 4	35 - 55
No. 8	5 - 25
No. 16	3 - 11
No. 50	2 - 7

**SECTION 705 - STONE BLANKET PROTECTION
AND FILTER BLANKET MATERIALS**

705.01--Stone Blanket Protection. In addition to meeting the quality requirements of AASHTO Designation: M 80, Class E, stone blanket protection shall be in accordance with AASHTO Designation: M 43, Size No. 357.

705.02--Stone Filter Blanket. In addition to meeting the quality requirements of AASHTO Designation: M 80, Class E, filter blanket material shall conform to

the gradation requirements of AASHTO Designation: M 43, Size No. 467.

705.03--Sand Filter Blanket. The sand filter blanket shall conform to the gradation requirements of Subsection 703.02 for concrete sand.

705.04--Stone Riprap. Aggregate for loose riprap, stone riprap for foundation protection, or that to be grouted shall consist of field stone, broken concrete, or rough, unhewn quarry stone as nearly rectangular in section as is practicable. The stone shall be dense, free of clay or shale seams, resistant to the action of air and water, and suitable in all other respects for the purpose intended. Quality requirements for rock to be furnished under these specifications will be checked or tested as determined by the State Materials Engineer prior to use and subsequently if deemed appropriate.

Stones for riprap, of the size specified, shall meet the requirements for size by weight of the mass as specified in the following table:

PERCENTAGE LARGER THAN
By Weight of the Mass

Rock Size	Size								
	8 Ton	4 Ton	2 Ton	1 Ton	1/2 Ton	1/4 Ton	300 Pound	200 Pound	100 Pound
8 Ton	50	0							
4 Ton	85	50	0						
2 Ton	--	95	50	0					
1 Ton	--	--	95	50	0				
1/2 Ton	--	--	--	95	50	0			
1/4 Ton	--	--	--	--	95	50			
300 Pound	--	--	--	--	--	--	0		
200 Pound	--	--	--	--	--	--	--	0	
100 Pound	--	--	--	--	--	--	--	--	0
75 Pound	--	--	--	--	--	90	--	--	--
60 Pound	--	--	--	--	--	--	80	--	--
40 Pound	--	--	--	--	--	--	--	80	--
20 Pound	--	--	--	--	--	--	90	--	80
10 Pound	--	--	--	--	--	--	--	90	--
5 Pound	--	--	--	--	--	--	--	--	90

This table sets out minimum requirements for the large stone per size designation. The Contractor shall furnish material well graded with the smaller stones such that a homogeneous blanket of riprap will result with all interstices reasonably well filled with rock.

SECTION 706 - MASONRY UNITS**706.01--Brick.**

706.01.1--General. Brick shall have a fine-grained, uniform, and dense structure, and be free of lumps of lime, laminations, cracks, checks, soluble salts, or other defects which may in any way impair the strength, durability, appearance or usefulness of the brick for the purpose intended. Bricks shall emit a clear, metallic ring when struck with a hammer.

706.01.2--Building Brick. Unless otherwise stipulated, building brick shall conform to AASHTO Designation: M 114, Grade SW.

706.01.3--Sewer and Manhole Brick. Unless otherwise stipulated, brick for sewer and manholes shall conform to AASHTO Designation: M 91, Grade SM.

706.02--Concrete Brick. Concrete brick shall conform to ASTM Designation: C 55, Grade N, Type I.

706.03--Concrete Masonry Blocks. Concrete masonry blocks may be rectangular or segmented and, when specified, shall have ends shaped to provide interlock at vertical joints. The blocks shall conform to the requirements of ASTM Designation: C 139; or, for hollow blocks, to ASTM Designation: C 90, Grade N, Type I. Dimensions and tolerances shall be as specified.

706.04--Right-of-Way Markers.

706.04.1--General. Concrete right-of-way markers shall be constructed in conformity with the details shown on the plans and shall meet the requirements hereinafter set forth. When more than 20% of the units in a lot is rejected, the entire lot will be rejected.

706.04.2--Manufacture.

706.04.2.1--Description. The exposed portion of the marker shall present a smooth, uniform surface, free of honeycomb, chips, or other defects. The shape, dimensions, and placement of steel shall be in accordance with details shown on the plans. All letters, figures, or other markings shall be true to type and size shown on the plans, and shall be legible.

706.04.2.2--Materials. The materials used in the manufacture shall conform to the following:

706.04.2.2.1--Cement. The cement used shall meet the requirements of Section 701.

706.04.2.2.2--Aggregates. The aggregates used shall conform to the requirements of Subsections 703.02 and 703.03, except that the requirements for gradation will not apply.

706.04.2.2.3--Reinforcing Steel. Reinforcing steel shall conform to the requirements of Subsection 711.01.

706.04.2.2.4--Proportions. The concrete shall have a minimum cement factor of 1.25.

706.04.2.2.5--Strength Requirements. The strength of the right-of-way markers shall be determined by the beam method. Under the beam method, a completed unit is loaded at the midpoint of an 18-inch span with three-edge bearing; the unit shall develop a strength of not less than 12,000 pounds, total load. Two specimens will be tested for each 200 units, or increment thereof; one to destruction and one to the ultimate load of 12,000 pounds.

SECTION 707 - JOINT MATERIALS

707.01--General. Joint fillers and seals for concrete bridges, concrete pavements or base course, and culvert pipe shall conform to the following applicable subsections.

707.02--Joint Fillers.

707.02.1--Poured Joint Filler.

707.02.1.1 Asphalt Joint Material. Poured asphalt filler shall be blown asphalt, Grade AC-13, conforming to the requirements of Subsection 702.05.

707.02.1.2--Polymerized Emulsified Asphalt Joint Material. Cold applied polymerized-emulsified asphalt joint material shall meet the following requirements when tested in accordance with AASHTO Designation: T 59 and as specified below:

	Minimum	Maximum
Tests on Emulsion		
Viscosity, Saybolt FuroI @ 122°F, seconds	50	450
Storage Stability, 24 hr., % *	-	1
Classification Test	Pass	
Particle Charge Test	Positive	
Cure Test **	Pass	
Stretch Test ***	Pass	
Distillation:		
Oil distillate by volume of emulsion %	-	2
Residue from distillation, %	65	-

Tests on Residue from Distillation

Penetration, 77°F, 100 g., 5 seconds	80	150
Ductility, 77°F, cm	40	-
Solubility in Trichloroethylene, %	97.5	-

- * Note 1: Upon examination of the test cylinder after standing undisturbed for 24 hours, the surface shall show no white, milky colored substance but shall be a homogeneous brown color throughout.
- ** Note 2: Cure Test - Pour approximately one milliliter of the emulsion onto a metal surface. Allow to cure at a minimum temperature of 80°F under a bright light for four hours. Outside in the sun may be used as the test site. After the four-hour curing period, the material shall show no tackiness or tendency to stick to the finger when pressed.
- *** Note 3: Stretch Test - Pour onto a one-quart friction lid, or similar flat container, enough emulsion to cover the surface. While the emulsion is still brown, embed with thumb pressure several clean, sharp edged rocks of 3/8 to 1/2 inch size. Cure in oven at 100°F for a minimum of eight hours. Remove from oven and allow to cool at room temperature for one hour. Upon lifting a rock from the surface, the asphaltic material must stretch for a distance of three inches before breaking.

707.02.1.3--Concrete Joint Sealer Compound - Hot-Poured Elastic Type. Concrete joint sealer compound, hot-poured elastic type, shall conform to the requirements of AASHTO Designation: M 173.

707.02.1.4--Silicone Sealant. The silicone sealant must have been approved for listing in the Department's "Approved Sources of Materials" prior to its use. The silicone sealant shall be a single-component low modulus non-acetic acid cure sealant which does not require a primer for bond to concrete. Unless specifically designated otherwise, silicone sealant shall be either the standard non-sag type or the self-leveling type meeting the following requirements:

PHYSICAL REQUIREMENTS

Property	Standard Non-Sag Type	Self- Leveling Type
Shore A Durometer Hardness, 7-day cure @ 73.4 ±3.6°F & 45% to 55% R.H., ASTM Designation: D 2240	10 - 25	15 maximum
Elongation, 7-day cure @ 73.4 ±3.6°F & 45% to 55% R.H., ASTM Designation: D 412, Method A, Die C, minimum	500%	500%
Tensile Stress @ 150% Elongation, 7-day cure @ 73.4 ±3.6°F & 45% to 55% R.H., ASTM Designation: D 412, Method A, Die C	20 - 45 psi	10 - 30 psi
Flow/Sag, ASTM Designation: C 639, maximum	0.3 inch	Self-Leveling
Tack-Free Time, 73.4 ±3.6°F & 45% to 55% R.H., ASTM Designation: C 679, maximum	90 minutes	180 minutes
Shelf Life from Date of Manufacture, minimum	6 months	6 months

The manufacturer of the joint material shall furnish certified test results of each lot of material furnished to each project. Each lot of the sealant shall be delivered in containers plainly marked with manufacturer's name or trade mark, lot number and date of manufacture.

707.02.1.5--Backer Rod for Use with Hot and Cold Poured Joint Sealer. The backer rod shall be a closed-cell foam rod made from polyethylene, polyolefin or similar type material and must have been approved for listing in the Department's "Approved Sources of Materials" prior to its use. The backer rod shall not wick water or retain moisture. The backer rod shall meet the following requirements:

Property	Value	Test Method
Density, maximum	2.5 lbs/ft ³	ASTM D 1622
Tensile Strength, minimum	15 psi	ASTM D 1623
Water Absorption, maximum	0.02 g/cm ³	ASTM C 1016, Procedure A
Compression Deflection, maximum	25% at 10 psi	ASTM D 1621

Temperature Requirements, minimum	450°F	No visible damage, when in contact with hot sealant

NOTE: The temperature requirement shall not apply for use with cold-poured joint sealer.

707.02.1.6--Tar. Tar filler shall be produced from suitable gas-house, coke-oven, and/or water-gas tars and shall conform to the following requirements:

	Minimum	Maximum
Float Test at 122°F	75	100
Total Distillate, percent by weight to 572°F	-	25
Water, percent by volume		1
Bitumen soluble in CS ₂ , percent	80	-
Softening Point of Residue (R & B), °F		162
Specific Gravity, 60°F/60°F	1.20	1.28

707.02.2--Preformed Joint Filler. Preformed joint filler shall conform to AASHTO Designation: M 153 for cork or sponge rubber types or AASHTO Designation: M 213 for bituminous types. The type required will be indicated on the plans.

707.02.3--Wood. Wood board joint filler shall be redwood, cypress, yellow pine, white pine, fir, longleaf pine, Tupelo gum, or other lumber classed as softwood, and shall conform to the following requirements:

Boards shall be free of knots, except that small pin knots 1/4 inch maximum diameter will be permitted. Boards containing occasional knots of larger size may be used, provided the knots are removed and the holes either filled with properly sized plugs of the same type wood or covered with approved thin metal attached to the board. Occasional medium surface checks not to exceed 1/32 inch width and 10 inch length will be permitted, provided the board is free of defects that will impair its usefulness for the purpose intended.

Dimensions shall be as shown on the plans, and tolerances of plus or minus 1/16 inch thickness and plus or minus 1/8 inch width will be permitted. For slip-form paving a tolerance of minus 1/4 inch on each end in length will be permitted.

The oven-dry weight shall not exceed 38 pounds per cubic foot, and the load required to compress the material in an oven-dry condition to 50% of its thickness before test shall not be more than 2500 psi.

A sample shall be submitted for each shipment of 1000 linear feet or less. Each sample shall consist of a representative section at least 36 inches long and the full depth of the joint. Testing shall be in accordance with AASHTO Designation: T 42, as applicable.

The joint filler shall be a one-piece board or a lamination of like species of the required thickness, depth and lane width length without joints or splicing except that milled shop finger end joints are permissible.

707.02.4--Preformed Joint Insert Material for Concrete Paving. Preformed joint insert material shall be composed of 1/4 x 2-inch preformed, non-extruding fiber board. The fiber shall be impregnated with asphalt or other approved binding material. The fiber board shall be of such character as not to be deformed or broken by twisting, bending, or other ordinary handling when exposed to atmospheric conditions. Pieces of the joint filler that have been damaged shall be rejected. This material is for use in longitudinal joints.

707.02.5--Preformed Elastomeric Compressive Joint Seals for Concrete. The preformed elastic joint shall be a polychloroprene joint sealer of the size and shape shown on the plans, bonded to the concrete with a lubricant adhesive and shall conform to AASHTO Designation: M 220.

The lubricant adhesive shall be in accordance with the recommendation of the manufacturer of the joint seals.

The Contractor shall submit the manufacturer's certified test results for each lot of joint seals.

707.03--Blank.

707.04--Rubber Type Gaskets for Joining Conduit. Rubber gaskets for pipe joints and revisions in design of pipe for installation of the gaskets shall conform to the requirements of AASHTO Designation: M 315. The Contractor shall submit the manufacturer's certified test results for each consignment of material.

707.05--Bituminous Plastic Sealer for Joining Conduit. Bituminous plastic sealer shall be composed of steam-refined petroleum asphalt or refined coal tar which has been dissolved in a suitable solvent and stiffened with an inert mineral filler.

The sealer shall be a smooth uniform mixture, not thickened or livered; it shall show no separation which cannot be easily overcome by stirring. The material shall be of such consistency and properties that it can be readily applied with a trowel, a putty knife, or a caulking gun without pulling or drawing. The material, when applied to pipe surfaces, shall exhibit good adhesive and cohesive properties and shall have only slight shrinkage after curing. The material shall be

capable of being exposed to below freezing temperatures without incurring damage. When applied in a layer of 1/16 inch to 1/8 inch thick on a tinned metal panel and cured at room temperature for 24 hours, the bituminous plastic sealer shall set to a tough plastic coating, free of blisters. Additional requirements are:

	Minimum	Maximum
Grease cone penetration, unworked, 150 grams, 25°C, 5 sec., ASTM Designation: D 217, mm/10	175	250
Weight, pounds per gallon	9.75	-
Non-volatile, 19 grams, 105°C - 110°C, 24 hrs., %	75	-
Ash, by ignition, %	25	55

707.06--Flexible Plastic Gasket for Joining Conduit. Gasket joint seals shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler and shall contain no solvents. The gasket joint sealer shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength and shall be supplied in extruded rope form of suitable cross-section and of such size as to fill the joint space when the pipes are laid. The gasket joint sealer shall be protected by a suitable removable two-piece wrapper. The two-piece wrapper shall be so designed that one-half may be removed longitudinally without disturbing the other half.

The material shall be obtained from sources approved by the laboratory, and the approval will be based on results of testing as required herein.

The Department may require the performance test described in AASHTO Designation: M 198.

Flexible plastic gasket shall also meet the following requirements:

	Minimum	Maximum	Test Method
Composition			
Bitumen / Petroleum Plastic Content	50	70	ASTM D 4
Ash-Inert Mineral Matter	30	50	AASHTO T 111
Volatile Matter	--	2.0	ASTM D 6
Property			
Specific Gravity at 77°F	1.20	1.35	ASTM D 71
*Ductility at 77°F (cm)	5.0	--	ASTM D 113
*Softening Point	320°F	--	ASTM D 36
*Penetration 77°F, 150 g, 5 sec.	50	120	ASTM D 217

* Due to the nature of the material, each sample to be tested must be manually kneaded, in lieu of heating and pouring, into the testing containers.

The Contractor shall furnish the Engineer three copies of the manufacturer's certificate, stating that the flexible plastic gasket meets all the requirements of these specifications and has the properties and characteristics herein specified.

707.07--Neoprene Expansion Joints.

707.07.1--General. Neoprene expansion joints shall consist of an integrally molded unit of neoprene and bonded metal components or neoprene extrusions bonded to steel extrusions so arranged as to provide for the expansion and contraction movements of the bridge deck.

707.07.2--Material Requirements. Materials used in the manufacture of the expansion joints shall meet the following requirements:

Neoprene shall meet the requirements of AASHTO Designation: M 220.

Steel plates bonded in the joints and steel extrusions shall conform to the requirements of ASTM Designation: A 36.

Aluminum plates used in the manufacture of the expansion joints shall conform to the requirements of ASTM Designation: B 209, Alloy 6061-T6.

Anchor bolts or studs shall be of a weldable alloy if arc welding is used, and shall conform to the strength requirements of ASTM Designation: A 307, Grade A Low Carbon Steel Fasteners.

707.07.3--Certification of Materials. The Contractor shall furnish the Engineer three copies of the manufacturer's certificate, stating that the expansion joint and each component material meets all the requirements of these specifications and have the properties and characteristics herein specified.

SECTION 708 - NON-METAL STRUCTURES AND CATTLEPASSES

708.01--General. The structures covered in these specifications are for use as pipe culverts, precast box culverts, cattlepasses, sidedrains, sewers, underdrains, and downspouts.

708.02--Concrete Pipe. Unless otherwise specified, pipe and tile shall conform to the requirements hereinafter set forth. When more than 20% of the pipe in a lot is rejected, the entire lot of pipe will be rejected.

When elliptical reinforcing is used, lift holes shall be cast in the top and "Top" or "Bottom" shall be clearly inscribed or stenciled on the inside of the pipe to indicate the proper position when laid. When it is found that the position for laying is not marked, or is marked improperly, the entire lot of such pipe will be

rejected.

When rubber gasket joints are permitted or specified, the pipe joints shall be so constructed as to accommodate this type of jointing.

708.02.1--Materials for Use in Concrete Pipe.

708.02.1.1--Cement. Portland Cement Types I, II or III, or blended hydraulic cement, shall conform to the requirements set out in Section 701.

708.02.1.2--Fly Ash. Fly ash conforming to the requirements of Subsection 714.05 may be used to replace portland cement on a one to one replacement rate but not to exceed 20 percent by weight of the portland cement.

708.02.1.3--Fine Aggregate. Fine aggregate shall consist of natural sand and shall conform to the requirements set out in Subsection 703.02, except that the requirements for gradation are not applicable.

708.02.1.4--Coarse Aggregate. Coarse aggregate shall consist of gravel or crushed limestone conforming to the requirements of Subsection 703.03, except that the requirements for gradation are not applicable. Concrete pipe made with crushed limestone coarse aggregate will not be permitted for use on a project with a soil pH lower than 4.5.

708.02.1.5--Water. The water shall conform to the requirements set out in Subsection 714.01.2.

708.02.1.6--Reinforcement. Reinforcement shall consist of wire conforming to the applicable requirements of Subsection 711.02.

708.02.2--Manufacture. General. Circular pipe of 54-inch diameter and smaller shall be machine made. Other pipe may be either machine made or wet cast.

All sizes of concrete pipe may be furnished with either bell and spigot or tongue and groove, provided that the minimum thickness of concrete on the groove end is at least 1¼ inches. This measurement for thickness will be made at a point 3/8 inch from the outer end of the groove.

When no particular length is specified, the pipe shall be manufactured in standard lengths of at least 2½ feet and not more than eight feet.

The pipe shall be constructed in such a manner and of such design that the joint will meet the same requirements for strength stipulated for the pipe.

708.02.3--Exceptions to AASHTO Standard Specifications.

708.02.3.1--Liquid Membrane Curing Compound. Liquid membrane curing compound will not be permitted.

708.02.3.2--Marking. Required markings shall be placed on the inside wall of the pipe. Machine made pipe shall be inscribed on the outside of the pipe and stenciled on the inside, other pipe may be stenciled. The specification designation for reinforced pipe may be excluded from the required markings.

708.02.3.3--Basis of Acceptance. All pipe will be tested under Option I, three-edge bearing test, or Option II, cylinder test, as set forth in Department SOP.

Pipe having a diameter of 30 inches or less will be tested under Option I.

Pipe larger than 30 inches in diameter will be tested under Option I or II. The pipe producer shall advise the Testing Engineer in writing of the option under which the pipe will be tested. The option chosen will remain in effect until rescinded in writing.

Flared end sections and cattlepasses will be tested under Option II unless otherwise authorized by the Testing Engineer.

The specified D-load and compressive strength shall be considered as minimum and allowable failures will not apply.

Normally, neither the absorption test nor the ultimate load will be required.

708.02.3.4--Rejection. All pipe shall be subject to rejection for nonconformance to the specifications. Individual sections of pipe may be rejected for one or more of the following:

- Visible fractures or cracks, except for a single end crack that does not exceed the depth of the joint.

- Defects that indicate imperfect proportioning, mixing, and molding.

- Surface defects indicating honey-combed or open texture.

- Damaged or cracked ends which would prevent a satisfactory joint.

- Defects indicating incorrect positioning of reinforcing steel.

708.02.3.5--Repairs. Repairs will not be permitted in the barrel of the pipe. Repairs may be made on the ends, tongue and groove or bell and spigot, with an approved commercial concrete patching compound used according to manufacturer's recommendations and properly cured.

708.02.3.6--Tongue and Groove. The thickness of the tongue shall not vary

more than 1/4 inch or five percent of the wall thickness, whichever is greater, when measured at the outer edge. The thickness of the groove shall not vary more than 1/4 inch or five percent of the wall thickness, whichever is greater, when measured at a point 3/8 inch from the outer end of the groove. The depth of the groove shall not vary more than 1/4 inch from the length of the tongue.

708.02.3.7--Lift Holes. Lift holes may be formed, punched, or drilled in plastic concrete. Lift holes may be placed in cured pipe only by drilling with a diamond core-drill bit.

708.02.4--Nonreinforced Concrete Pipe. In addition to the applicable requirements of Subsection 708.02, nonreinforced concrete pipe shall meet the requirements of AASHTO Designation: M 86 for the class specified. Testing shall be in accordance with AASHTO Designation: T 280.

708.02.5--Reinforced Concrete Pipe. All reinforced concrete pipe except Class V pipe with diameters of 54 inches and larger shall meet the requirements of AASHTO Designation: M 170 as modified by Subsection 708.02.

Class V pipe with diameters of 54 inches and larger shall meet the requirements of AASHTO Designation: M 170 or M 242 as modified by Subsection 708.02 and herein.

Circular reinforced concrete pipe with S-stirrup reinforcement shall be in accordance with Figure 1 and the following requirements.

The wall thickness, amount of circular reinforcement, S-stirrup system and concrete strength shall comply with those set out in Table 1 herein. The spacing center to center of adjacent inner rings of circumferential reinforcement in a cage shall not exceed 4 inches for pipe up to and including pipe having a 4-inch wall thickness nor exceed 5½ inches for 54 inch pipe and 6 inches for all other pipe sizes.

Each line of S-stirrups shall have a continuous S shape extending longitudinally from end to end of the pipe. They shall extend from the inner cage toward the outer surface of the pipe for a distance not less than the minimum amplitude. S-stirrups shall pass around and be in contact with each inside circumferential member of the inner cage. Each line of S-stirrups shall lie essentially in a plane passing through the longitudinal axis of the pipe.

Where more than one length of stirrup material is used per line, a lap around one circumferential member of the inner cage shall be made. The ends of "S" shaped stirrups at splices shall include an outer bend. Not more than three lengths of S material may be used in a line, and the minimum length of a section of S-stirrups shall be 30 inches.

All designs in Table 1 are accepted designs with noted 0.01 inch crack and ultimate D-load.

Additional Markings. After the capital letter "D" designating the D-load, show the design wall thickness in inches expressed as a decimal. Pipe with "S" stirrups shall have the symbol S. Pipe requiring axis orientation without lift holes, i.e. stirrup pipe, quadrant reinforced pipe, shall have the center line of the crown of the pipe marked inside and outside with the symbol TB. Pipe with quadrant steel shall be marked with the symbol Q. Pipe with deformed wire reinforcement required in the design shall have the symbol DF.

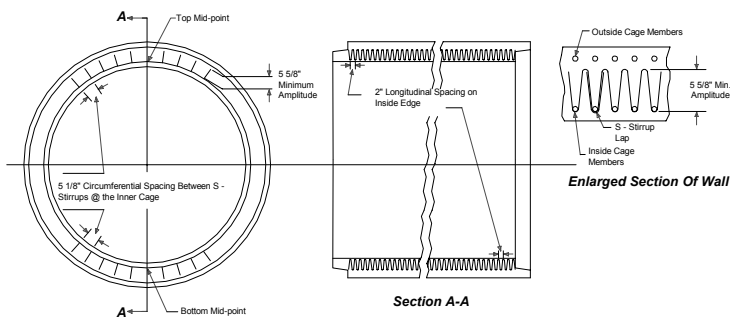


Figure 1

Illustrative Example of S-Stirrup Support System for 0.01-inch Crack D-load 3,000 102-inch Diameter Pipe, Minimum Area Per Support 0.053 Square Inch., 11 Lines Spaced @ 5 1/8 inches. For Other Classes and Sizes, See Table.

TABLE 1
0.01 Inch Crack D-Load 3,000
Ultimate Strength D-Load 3,750

Internal Diameter of Pipe	Wall Thickness	Circular Reinforcement in Circular Pipe		“S” Stirrups				
		Inner Cage	Outer Cage	Minimum Area Per Support Element	Number of Lines*	Longitudinal Spacing	Circumferential Spacing on Inner Cage	Minimum Amplitude** of Stirrups,
inches	inches	square inches per foot of pipe	square inches per foot of pipe	square inches		inches	inches	inches
Concrete Strength 5,000 Psi								
54	5 1/2	0.64	0.48	0.029	15	2	2 1/8	2 5/8
60	6	0.70	0.53	0.029	14	2	2 5/8	3 1/8
66	6 1/2	0.79	0.59	0.029	13	2	3 1/8	3 5/8
72	7	0.87	0.66	0.029	12	2	3 5/8	4 1/8
78	7 1/2	0.92	0.69	0.031	11	2	4 1/8	4 5/8
84	8	0.99	0.74	0.034	11	2	4 5/8	5 1/8
90	8	1.13	0.85	0.041	11	2	4 5/8	5 1/8
96	8 1/2	1.20	0.90	0.045	11	2	5 1/8	5 5/8
102	8 1/2	1.34	1.00	0.053	11	2	5 1/8	5 5/8
108	9	1.51	1.13	0.063	11	2	5 5/8	6 1/8
114	9 1/2	1.51	1.13	0.064	11	2	6 1/8	6 5/8
120	10	1.62	1.21	0.068	11	2	6 1/2	7 1/8
126	10 1/2	1.73	1.30	0.072	11	2	6 7/8	7 5/8
132	11	1.84	1.38	0.076	11	2	7 1/4	8 1/8
144	12	2.09	1.57	0.085	11	2	8	9 1/8

* Number of lines in the table indicates the number of longitudinal lines required in each top and bottom portion of the pipe. The area of each support element in a pipe is 2 times the cross-sectional area of the “S” stirrups wire used. There shall be an equal number of these lines of “S” stirrups on either side of the mid-point of both the top and bottom of the pipe. See Fig. 1.

** The amplitude is the overall width of the line of stirrups.

708.03--Concrete Cattlepasses. Concrete cattlepasses shall conform to the plans, the applicable requirements of Subsection 708.02, and the following: The requirements as to manufacture, materials, and curing shall conform to the requirements of AASHTO Designation: M 170. The compressive strength of the concrete shall be at least 4000 psi at 28 days.

708.04--Reinforced Concrete Flared-End Section. Reinforced concrete flared-end sections shall conform to the plans, the applicable requirements of Subsection 708.02 and the following: The requirements as to manufacturer, materials, and curing shall be the same as for the connecting pipe. The compressive strength of the concrete shall be at least 3000 psi at 28 days.

708.05--Perforated Concrete Pipe. Perforated concrete pipe shall conform to the requirements of Subsection 708.02.4 and AASHTO Designation: M 175.

708.06--Concrete Drain Tile. Standard drain tile or extra quality drain tile shall conform to the applicable requirements of AASHTO Designation: M 178.

708.07--Porous Concrete Pipe for Underdrains. Porous concrete pipe for underdrains shall conform to the requirements of AASHTO Designation: M 176.

708.08--Blank.

708.09--Blank.

708.10--Blank.

708.11--Blank.

708.12--Blank.

708.13--Blank.

708.14--Reinforced Concrete Arch Pipe. Reinforced concrete arch pipe shall meet the requirements of AASHTO Designation: M 206. Horizontal elliptical pipe may be furnished in lieu of arch pipe.

708.15--Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe. This pipe shall conform to the requirements of AASHTO Designation: M 207.

708.16--Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets. The joints shall conform to the requirements of AASHTO Designation: M 198.

708.17--Corrugated Plastic Pipe Culverts.

708.17.1--Corrugated Polyethylene Pipe Culverts. Corrugated polyethylene pipe shall conform to the requirements of AASHTO Designation: M 294, Type S.

The Contractor shall furnish to the Engineer three copies of the manufacturer's certified test reports and certification covering each shipment of pipe stating the amount furnished and that the pipe, fittings, couplings, etc. comply with the requirements of the specifications. Certifications and certified test reports for compliance with this specification shall be performed by an approved third-party testing source.

708.17.2--Corrugated Poly (Vinyl Chloride) (PVC) Pipe Culverts. Corrugated poly (vinyl chloride) (PVC) pipe shall conform to the requirements of ASTM Designation: F 949.

The Contractor shall furnish to the Engineer three copies of the manufacturer's certified test reports and certification covering each shipment of pipe stating the amount furnished and that the pipe, fittings, etc. comply with the requirements of the specifications.

708.18--Sewer Pipe Used for Underdrains.

708.18.1--General. Pipe less than four inches in diameter shall conform to commercial grade PVC water pipe.

Perforations, when required, shall be circular and conform to the requirements of AASHTO Designation: M 278.

708.18.2--Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe. This pipe and fittings used for underdrains shall meet the requirements of ASTM Designation: D 2751 for the pipe SDR number specified.

708.18.3--Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe. This pipe and fittings used for underdrains shall meet the requirements of ASTM Designation: D 3034 for the pipe SDR number specified.

708.18.4--Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe. This pipe with a smooth interior and fittings shall conform to the requirements of ASTM Designation: F 949. The pipe is for use in non-pressure drainage applications as an alternate to ABS and PVC sewer pipe when the SDR number is specified as 35 or greater.

708.19--Corrugated Polyethylene Drainage Tubing. This tubing used for underdrains shall meet the requirements of AASHTO Designation: M 252, Type S and/or Type SP, as applicable.

708.20--Perforated Semicircular Plastic Pipe for Underdrains.

708.20.1--General. Semicircular plastic subdrain pipe is intended for direct burial and shall be extruded from thermoplastic materials as specified below. Unless otherwise specified, the pipe shall be supplied in 20-foot lengths. The pipe shall have an expanded bell on one end for direct coupling, or separate couplings shall be supplied. The pipe sections shall be joined by a friction fit.

The pipe fittings including straight couplings, end caps, tees, right laterals, left laterals, 45° elbows, and 90° elbows shall be molded from thermoplastic materials as specified below. Fabricated fittings shall be made of the same material as the pipe sections.

708.20.2--Pipe Sections and Fabricated Fittings. The pipe sections and fabricated fittings shall be made from virgin poly vinyl chloride (PVC). PVC resins shall conform to ASTM Designation: D 1784, Class 12454-B. Virgin resin is defined as resin which contains not more than 10 percent regrind material and has not previously been used to make another product.

708.20.3--Molded Fittings. Molded fittings shall be made from virgin high density polyethylene (HDPE) conforming to ASTM Designation: D 1248, Type III, Class B, Category 3; with the addition of a minimum of 0.25% carbon black.

708.20.4--Workmanship. The plastic pipe and fittings shall be homogeneous throughout and free of visible surface flaking, chips or cracks. The semicircular trough interior shall be smooth and free from obstructions. The products shall be as uniform as commercially practicable in respect to color, opacity, density and other physical properties.

708.20.5--Dimensions. The minimum wall thickness of the pipe at any point shall be 0.125 inch, protective lip excluded. Sufficient additional wall thickness shall be supplied at perforated areas to maintain an effective wall strength equal to 0.125 inch thick nonperforated wall. The protective lip shall extend a minimum of 0.500 inch from the pipe at an angle of approximately 30°. The nominal inside radius of the semicircular trough shall be 2 5/16 inch, providing a minimum cross-sectional flow area of 8.3 square inch below the water entry level. Total water intake area shall be 3.5 square inch per linear foot. All measurements shall be taken at 72 ±5°F.

708.20.6--Load Deformation. At a deflection of 0.2 inch, the minimum pipe stiffness, $F\Delta y$, shall be 100 psi when tested in accordance with ASTM Designation: D 2412, except that specimens shall be conditioned a minimum of 12 hours at approximately 72°F.

708.20.7--Impact Resistance. Impact resistance of the plastic pipe and fittings shall be as follows when tested in accordance with ASTM Designation: D 2444, except that specimens for routine inspection shall be conditioned for a minimum

of one hour at approximately 72°F or two hours at approximately 32°F.

Using a 20-pound Tup B, the plastic pipe and fittings shall be capable of withstanding 125 foot-pounds at 72°F and 62 foot-pounds at 32°F.

708.20.8--Hydrocarbon Resistance. The plastic pipe and fittings shall meet the load deformation requirements specified above after being immersed for seven days in normal heptane as specified in ASTM Designation: D 543.

708.20.9--Product Marking. Each section of pipe and each fitting shall be clearly marked on the exterior surface to show the manufacturer's name or trademark and the material from which it is made, PVC or HDPE. Product marking shall be permanent and legible in characters at least 3/8 inch high.

708.20.10--Packing and Storage. All pipe sections and fittings shall be so stored prior to shipment that they do not warp, deteriorate or suffer dimensional distortion.

All pipe sections shall be banded or palletized so as to protect them during shipment, handling and subsequent storage. Fittings shall be banded together or packed in suitable containers.

708.21--Blank.

708.22--Precast Concrete Box Culvert.

708.22.1--General. Precast concrete box culverts shall conform to the design and dimensions shown on the plans, and the materials and manufacture of box sections shall meet the requirements of AASHTO Designation: M 259 or M 273, as applicable, with the following exceptions:

708.22.2--Exceptions to AASHTO.

Cement shall meet the requirements of Section 701.

Aggregates shall meet the requirements of Subsections 703.02 and 703.03, except that gradation will not apply.

Admixtures and blends may be used with the approval of the Engineer.

Reinforcement shall meet the requirements of Subsection 711.02.3.

Water shall meet the requirements of Subsection 714.01.

A lot will consist of a group of 15 box sections of a single size or fraction thereof; or all units produced in one calendar week, Sunday through Saturday,

whichever comes first.

Each line of box section should be manufactured by one producer's plant.

The slab and wall thickness shall not vary from the design dimensions by more than five percent or 3/16 inch, whichever is greater.

The depth of cover and amount of steel may, at the discretion of the Testing Engineer, be checked by an electro magnetic device.

The permissible variation in diameter of any wire in finished fabric shall conform to the tolerances prescribed for the wire before fabrication by AASHTO Designation: M 32.

Box sections may be repaired, if necessary, because of occasional imperfections in manufacture or handling damage and will be acceptable if, in the opinion of the Engineer, the repairs are sound, properly finished, and cured and the repaired box section conforms to the specifications. These repairs will be allowed in the ends and on joints, only. No repairs will be allowed in the barrel of the box section.

708.23--Special Sections. Any special section, not otherwise specified, shall be of the same wall thickness, size, and type as the pipe to which it is joined and shall conform to the applicable requirements for the particular type of pipe as set forth therein.

Elbows, tees, wyes, or other such special sections shall, unless otherwise specified, have a minimum length for each projection sufficient to properly join the section to the joining elements of the completed structure.

Other details shall be as shown on the plans.

SECTION 709 - METAL PIPE

709.01--Cast Iron Culvert Pipe. Cast iron culvert pipe shall conform to ASTM Designation: A 716, for the wall thicknesses set out in the Tables, or as specified on the plans.

709.02--Corrugated Metal Culvert Pipe and Pipe Arches. All corrugated metal pipe and arches covered in these specifications shall conform to AASHTO Designation: M 36, except the minimum gauge thickness shall be as shown on the plans or in the contract; however, corrugated metal pipe manufactured from sheets thicker than that specified will be acceptable when approved by the Engineer. The internal diameter of corrugated metal pipe will be determined by inside measurement between the crests of the corrugations. Corrugations greater

than 3" x 1" will not be allowed in arch pipe.

709.03--Bituminous Coated Corrugated Metal Pipe and Pipe Arches.

709.03.1--Materials. Bituminous coated corrugated metal pipe and arches shall conform to the requirements of Subsection 709.02 and, in addition, shall be completely coated inside and out with an asphalt cement which will meet the performance requirements hereinafter set forth.

The pipe shall be coated uniformly to a minimum thickness of 0.05 inch, measured on the crest of the corrugations. The asphalt cement used shall be at least 99.5% soluble in carbon disulphide.

709.03.2--Performance Requirements. The asphalt cement shall adhere to the metal tenaciously, shall not chip off in handling, and shall protect the pipe from deterioration as evidenced by successfully withstanding the following tests:

709.03.2.1--Stability Test. Parallel lines shall be drawn along the valleys of the corrugations of a representative sample of coated pipe and the specimen placed on end in a constant-temperature oven with the parallel lines in a horizontal position.

The temperature of the specimen shall be maintained at a temperature of $150 \pm 2^{\circ}\text{F}$ for a period of four hours. At the end of this time, no part of any line shall have dropped more than 1/4 inch.

709.03.2.2--Imperviousness Test. The asphalt cement shall be impervious to liquids as indicated by the following tests: 25 to 50 milliliters of a 25% water solution of sulfuric acid and of a 25% water solution of sodium hydroxide shall be placed in separate corrugations for a period of 48 hours, during which time no loosening or separation of the bituminous material from the metal shall have taken place.

709.04--Bituminous Coated Paved Invert Corrugated Metal Pipe and Arches. Bituminous coated corrugated metal pipe and arches with paved invert shall conform to the requirements of Subsection 709.03 and the requirements set out below.

Bituminous material shall be applied in such a manner that a smooth pavement will result in the invert (bottom of pipe when installed) for 1/4 of the circumference of circular pipe and 40% of the circumference of pipe arches. The pavement, except where the upper edges intersect the corrugations, shall have a minimum thickness of 1/8 inch above the crest of the corrugations.

709.05--Polymer Coated Corrugated Metal Pipe and Pipe Arches. Polymer coated corrugated metal pipe and arches shall conform to the requirements of

709.02 and AASHTO Designation: M 245. The polymer precoated sheet shall be Type B with a minimum coating thickness of 0.010 inches or 0.25 millimeters on both surfaces.

709.06--Corrugated Metal Pipe for Underdrains. Corrugated metal pipe shall conform to AASHTO Designation: M 36.

709.07--Bituminous Coated Corrugated Metal Pipe for Underdrains. Bituminous coated corrugated metal pipe shall be pipe conforming to Subsection 709.06 with a bituminous coating applied in accordance with the requirements of Subsection 709.03.

709.08--Polymer Coated Corrugated Metal Pipe for Underdrains. The metal pipe for underdrains shall conform to the requirements of Subsection 709.06 and the polymer coating shall conform to the requirements of Subsection 709.05.

709.09--Corrugated Aluminum Alloy Culvert Pipe and Arches. Corrugated aluminum culvert pipe and arches shall conform to the requirements of AASHTO Designation: M 196. Minimum thickness of sheets shall be as indicated on the plans or in the special provisions.

709.10--Corrugated Aluminum Alloy Pipe for Underdrains. Corrugated aluminum pipe underdrains shall conform to the requirements of AASHTO Designation: M 196.

709.11--Bituminous Coated Corrugated Aluminum Alloy Culvert Pipe and Arches. Bituminous coated aluminum culvert pipe and arches shall conform to AASHTO Designation: M 196, and in addition shall be coated inside and out as specified in Subsection 709.03.

709.12--Bituminous Coated Paved Invert Corrugated Aluminum Alloy Culvert Pipe and Arches. Bituminous coated corrugated aluminum culvert pipe and arches with paved invert shall conform in every respect to the requirements of Subsection 709.09 and, in addition, to the requirements of Subsection 709.04 for paved invert.

709.13--Bituminous Coated Corrugated Aluminum Alloy Pipe for Underdrains. This pipe shall conform to AASHTO Designation: M 196 and shall be coated with bituminous material conforming to AASHTO Designation: M 190, type coating as specified.

709.14--Structural Plate for Pipe, Pipe Arches, and Arches. These conduits and bolts and nuts for connecting plates shall conform to AASHTO Designation: M 167.

709.15--Full Bituminous Coated Structural Plate Pipe, Pipe Arches, and

Arches. These conduits shall conform to AASHTO Designation: M 167 and shall be coated with bituminous material conforming to AASHTO Designation: M 190, type coating as specified.

709.16--Aluminum Alloy Structural Plate for Pipe, Pipe Arches, and Arches. These conduits and the bolts and nuts for connecting plates shall conform to AASHTO Designation: M 219.

709.17--Full Bituminous Coated Aluminum Alloy Structural Plate Pipe, Pipe Arches and Arches. These conduits shall conform to AASHTO Designation: M 219 and shall be coated with bituminous material conforming to AASHTO Designation: M 190, type coating as specified.

709.18--Special Sections. Any special sections, such as elbows, flared end sections, branch connections, or other specified appurtenances shall be of the same base metal, size, type, fabrication, coating, invert, and other applicable requirements as for the particular type of pipe to which it is joined.

Each elbow shall be not less than the following length:

<u>Diameter</u>	<u>Angle - Up to and Including</u>	<u>Minimum Overall Length</u>
6-inch to 48-inch	22½°	24 inches
54-inch to 84-inch	22½°	48 inches
6-inch to 36-inch	45°	24 inches
42-inch to 84-inch	45°	48 inches
6-inch to 24-inch	60°	24 inches
30-inch to 60-inch	60°	48 inches
66-inch to 84-inch	60°	72 inches
6-inch to 15-inch	90°	24 inches
18-inch to 36-inch	90°	48 inches
42-inch to 60-inch	90°	72 inches
66-inch to 84-inch	90°	96 inches

Other details shall be as shown on the plans.

All three-piece corrugated metal end sections shall have 12 gauge minimum thickness sides and 10 gauge minimum thickness center panels. Width of center panels shall be greater than 20 percent of the pipe periphery. Multiple panel bodies shall have lap seams tightly joined by three-eighths inch diameter galvanized rivets or bolts. For 60-inch thru 84-inch sizes, reinforced edges shall be supplemented with galvanized stiffener angles. The angles shall be two inches by two inches by one-quarter inch for 60-inch thru 72-inch diameters and two and one-half inches by two and one-half inches by one-quarter inch for 78-inch and 84-inch diameters. The angles shall be attached by three-eighths inch diameter galvanized nuts and bolts. For the 79-inch by 49-inch and 85-inch by

54-inch sizes, reinforced edges shall be supplemented by galvanized stiffener angles which are two inches by two inches by one-quarter inch. Angle reinforcement shall be placed under the center panel seams on the 79-inch by 49-inch and 85-inch by 54-inch sizes. A toe plate of the same materials as the end section shall be furnished and installed on each end section, unless deemed by the Engineer to be unnecessary for the particular location.

709.19--Steel Pipe and Steel Pipe Encasements. Steel pipe shall conform to the design and dimensions shown on the plans, and materials shall meet the requirements hereinafter specified.

Steel pipe with a nominal diameter of less than six inches shall meet the requirements of ASTM Designation: A 53, Type E or F, Grade A, Black, Schedule 40.

Steel pipe with nominal diameter of six inches or more shall meet the requirements of ASTM Designation: A 139, Grade A unless otherwise specified, Welded, Black, for the wall thicknesses set out in the Tables, or as specified on the plans.

Steel pipe with a nominal diameter greater than 24 inches shall be as specified on the plans.

Unless otherwise indicated on the plans, steel pipe ends shall be factory beveled for welding. The Contractor shall furnish the State Materials Engineer the original and three copies of the Mill Certificate of Compliance for all materials furnished.

SECTION 710 - PAINT

710.01--General. All paint materials, including vehicle, pigment, paste, driers, thinners, and mixed paint shall conform to the requirements of these specifications unless otherwise stipulated. Paint shall be furnished ready-mixed or in paste or powder form, as may be specified, and shall be of the type and color shown on the plans or as otherwise indicated. All paints for incorporation in the work shall be manufactured in the United States. Any paint that has caked, hardened or otherwise deteriorated shall not be used.

710.01.1--Sampling and Testing. Sampling and testing of paint shall be in accordance with the appropriate method in Federal Test Method No. 141, ASTM and/or Mississippi Test Method.

Sampling at the option of the Department will be performed at the point of manufacture or at a designated point of delivery. When the paint is sampled at the point of manufacture, the Department representative shall be given full access

to the manufacturing process.

The Central Laboratory may utilize x-ray analysis, gas chromatography, infrared, or ultra violet spectral analysis of the paint or its components to determine whether specified ingredients were used. Paint found not to be in compliance with the approved formula shall not be used.

710.01.2--Containers and Marking. Paint shall be shipped in sturdy leak proof containers. The size of the containers shall be at the option of the Contractor unless specified otherwise in the contract.

Each container or label thereon shall be marked as follows:

- Net weight in pounds
- Net volume in U. S. gallons
- Color
- Code number
- Batch number
- Name and percentage of each component
- Name and address of manufacturer
- Date of manufacture

In addition, each container and labeling thereon shall meet the requirements of State and Federal Regulations for transporting the paint.

710.02--Mixed Paints. Unless otherwise specified, paint shall be delivered completely mixed and ready for use without further additions or alterations. Paint shall be of a uniform consistency and when applied shall dry to a hard tough film without running, streaking or sagging.

All paints and components thereof shall conform to the applicable subsection as contained herein.

Mixed paint in storage shall not be exposed to temperatures less than 32°F., or such higher temperature as recommended by the paint manufacturer. Paint exposed to temperatures lower than specified will be subject to rejection or retesting.

710.02.1--Aluminum Paint. This paint shall be aluminum alkyd paint as specified by the Steel Structures Painting Council Paint Specifications SSPC 101-64T. Paint that is to be stored for periods longer than six months shall be a two component system. A two component paint shall be prepared by mixing two pounds of aluminum paste with one gallon of vehicle.

Type I Leafing Aluminum Paint shall always be used as the finish or top coat. Intermediate coats shall be alternate coats of Type II Non-Leafing Aluminum

Paint and Type I Leafing Aluminum Paint.

710.02.2--Fast Drying Acrylic Waterborne Traffic Paint. This specification covers fast drying acrylic waterborne, ready-mixed white and yellow traffic paints, Codes FDWBTW and FDWBTY.

710.02.2.1--Composition of Formulation. The composition of the paint shall be left to the discretion of the manufacturer as long as the finished product is composed of 100% acrylic emulsion, Rohm and Haas Emulsion E-2706 or Dow Chemical Emulsion DT 211NA, and meets the requirements of this specification and of any applicable Federal, State or Local regulations for products of this type.

The paint shall contain no lead, chromium, cadmium or barium. The organic yellow shall be pigment yellow C.I. #75 or #65. Rutile titanium dioxide shall be used in the yellow paint, FDWBTY.

710.02.2.1.1--Percent Pigment. The percent pigment by weight shall be not less than 45% nor more than 55%.

710.02.2.1.2--Total Non-Volatile. The paint shall have not less than 73% total non-volatiles by weight.

710.02.2.1.3--Non-Volatile Vehicle. The non-volatile portion of the vehicle shall be composed of a 100% acrylic polymer, Rohm and Haas Emulsion E-2706 or Dow Chemical Emulsion DT 211NA, and shall not be less than 44% by weight.

710.02.2.1.4--Organic Matter. The volatile content of the paint shall contain less than 150 grams of volatile organic matter per liter of total non-volatile paint material.

710.02.2.1.5--Solids Volume. The volume of solids shall be not less than 58%.

710.02.2.1.6--Weight per Gallon. The paint shall weigh a minimum of 12.0 pounds per gallon and the weight of the production batches shall not vary more than ± 0.2 pound per gallon from the weight of the qualification samples.

710.02.2.2--No Tracking Time. The paint shall dry to a no tracking condition under traffic in ninety (90) seconds maximum when applied at 15 ± 1 mil. wet film thickness and 110 to 140°F, and from three (3) to ten (10) minutes when applied at ambient temperature with six (6) pounds per gallon of Class A, Standard, glass beads or with twelve (12) pounds per gallon of Class B, High-Visibility, glass beads.

710.02.2.3--Viscosity. The consistency of the paint shall be not less than 75 nor

more than 95 Krebs Units (KU) at 77°F when tested in accordance with Federal Test Method Standard No. 141.

710.02.2.4--Flexibility. The paint shall show no cracking or flaking when tested in accordance with Federal Specification TT-P-1952.

710.02.2.5--Dry Opacity. The minimum contrast ratio shall be 0.96 when drawn with a 0.005 Bird applicator.

710.02.2.6--Daylight Reflectance. The daylight directional reflectance shall not be less than 85% for white paint and not less than 54% for yellow paint, relative to magnesium oxide, when tested in accordance with Federal Test Method No. 141.

710.02.2.7--Abrasion Resistance. No less than 180 liters of sand shall be required for removal of the paint film when tested in accordance with Federal Specification TT-P-1952.

710.02.2.8--Glass Bead Adhesion. The test for bead adhesion shall be conducted in accordance with the Abrasion Resistance Test with the exception that the test be modified to require glass beads to be uniformly applied on the paint by gravity flow at the rate of six (6) pounds per gallon for Class A, Standard, beads and 12 pounds per gallon for Class B, High-Visibility, beads. No less than 145 gallons of sand shall be required for the removal of the beaded film. The application of the glass beads is to be a separate operation, but applied at the same time as the paint.

710.02.2.9--Bleeding. The paint shall have a minimum bleeding ratio of 0.97 when tested in accordance with Federal Specification TT-P-1952. The asphalt saturated felt shall conform to Federal Specification HH-R-590.

710.02.2.10--Scrub Resistance. The paint shall pass 300 cycles minimum when tested in accordance with ASTM Designation: D 2486.

710.02.2.11--Freeze-thaw-Stability. The paint shall show no coagulation or change in consistency greater than five (5) Krebs Units, or a decrease in scrub resistance of greater than 10% when tested in accordance with Federal Specification TT-P-1952.

710.02.2.12--Dilution Test. The paint shall be capable of dilution with water at all levels without curdling or precipitation such that the wet paint can be readily cleaned up with water only.

710.02.2.13--Storage Stability. After 30 days storage in a three-quarters filled, closed container, the paint shall show no caking that cannot be readily remixed to a smooth, homogeneous state, no skinning, livering, curdling, or hard settling.

The viscosity shall not change more than five (5) Kreb Units from the viscosity of the original sample.

710.02.3.14--Acceptance Procedure. The traffic paint must be obtained from a manufacturer on the Department's "List of Approved Sources of Materials" for traffic paint manufacturers. Acceptance will be based on results of tests performed by MDOT Central Laboratory on random samples obtained from delivered batches. Certification, sampling and acceptance shall be in accordance with the requirements of MDOT S.O.P. No. TMD-30-01-00-000.

710.03--Inorganic Zinc Rich System.

710.03.1--Inorganic Zinc Primer. The shop coat or prime coat shall be a self-curing multiple component inorganic zinc rich primer conforming to the requirements of AASHTO Designation: M 300, Type I or Type II. The inorganic zinc rich primer, as applied, shall meet State and Federal regulations on Volatile Organic Compounds (VOC).

The inorganic zinc primer shall be formulated so as to produce a distinct contrast in color with the blast cleaned metal surface and the intermediate field coat to be applied thereon.

The inorganic zinc primer must be one from the Department's "List of Approved Sources of Materials."

The paint manufacturer's technical representative who is certified by the National Association of Corrosion Engineers (NACE) shall be present at the beginning of coating operations as needed to provide technical expertise in the application of the coating. This technical expertise shall be provided without additional cost to the Department. The fabricator is responsible for arranging for the presence of the manufacturer's technical representative.

710.03.2--Epoxy Mastic Field Touch-Up Paint. Inorganic zinc primer coat which has been damaged during storage, handling, transporting and/or erection shall be repaired using epoxy mastic touch-up paint prior to finish coating. Epoxy mastic touch-up paint shall be manufactured or recommended by the supplier of the inorganic zinc primer, shall be as listed on the Department's "List of Approved Sources of Materials" and, as applied, shall be VOC compliant with State and Federal Regulations.

The epoxy mastic touch-up paint shall conform to the same formulation as originally approved by the Department. Determination of conformance to the originally approved formulation will be based on physical tests and infrared spectrum. The results of these tests shall be in agreement with the results obtained on the originally approved formulation.

710.03.3--Acrylic Latex Intermediate and Top Coats, Field Coats. The acrylic latex field coats shall be manufactured by the supplier of the inorganic zinc primer coat, shall be as listed on the Department's "List of Approved Sources of Materials" and, as applied, shall be VOC compliant with State and Federal regulations. The acrylic latex paint shall conform to the same formulation as originally approved by the Department.

Determination of conformance to the originally approved formulation will be based on physical tests and infrared spectrum of the vehicle component. The infrared spectrum, 2.5 to 15 microns, of the vehicle component shall agree with the infrared spectrum of the vehicle component of the originally approved paints in both peak position and relative intensity of the peaks.

The color of the acrylic latex intermediate coat shall be white in color. The color of the acrylic latex top coat shall be light gray in color.

At the Engineer's request, the paint manufacturer's technical representative who is certified by the National Association of Corrosion Engineers shall be present at the job site at the beginning of each separate coating operation as needed to provide technical expertise in the application of the field coats. This technical expertise shall be provided without additional cost to the Department. The Contractor shall be responsible for arranging for the presence of the manufacturer's technical representative.

710.03.4--Mixing of Paint. All paint shall be mixed in accordance with the paint manufacturer's printed instructions.

710.03.5--Packaging and Marking. Multiple component paints shall be furnished in premeasured packages so as to form one unit of mixed paint when mixed with the vehicle in its container.

The containers for all paints shall be coated as necessary to prevent attack by the paint. Each container shall bear a label with the following information shown thereon: name and address of manufacturer, trade mark or trade name, kind of paint, date of manufacture and lot number, mixing instructions and equipment clean-up instructions. The VOC content shall be stated either on the label, product data sheet, or Material Safety Data Sheet.

710.03.6--Acceptance Procedure. Prior to use, the Contractor must furnish the Engineer a certificate from the manufacturer, covering each lot of paint in the shipment, attesting that the paint in the shipment conforms to the same formula as that originally approved by the Department.

Final acceptance of the paint will be based on results of tests performed by the Central Laboratory on samples obtained by the Department's representative prior to or after delivery. The use of any lot of paint prior to its final acceptance shall

be prohibited.

710.04--Epoxy Mastic System. The coating system shall consist of a modified epoxy mastic prime coat with a uniform dry film thickness of not less than five nor more than eight mils and a vinyl finish coat of not less than three nor more than five mils.

710.04.1--Prime Coat. The prime coat shall be a two-component epoxy mastic designed as a one-coat high-build complete protective coating system with excellent adhesion to rusted steel and old coating systems after such surfaces have been cleaned as specified.

710.04.1.1--Pigment. The silica and metallic aluminum pigment shall include rust inhibitors and adhesion reinforcers/ promoters. The aluminum factor shall contain both leafing and non-leafing types.

710.04.1.2--Vehicle. The vehicle shall be a modified epoxy-polyimide resin formulated to have suitable insensitivity to moisture and shall contain special wetting agents to insure adequate adhesion.

710.04.1.3--Mixed Paint. The mixed paint shall conform to the following requirements:

The catalyzed epoxy shall contain $92 \pm 2\%$ solids by weight when tested in accordance with ASTM Designation: D 1644, modified to a drying time of 72 hours at 100°F.

Total solids by volume shall be a minimum of 90%.

The coating shall air cure to a hard, tough film within five days at a temperature of 75°F. It shall be dry to the touch in 24 hours at 75°F. The usable pot life of the mixed paint shall be not less than four hours at 75°F and two hours at 90°F.

It shall exhibit good compatibility with inorganic zinc primers.

The color shall contrast with the steel and the finish coat.

The catalyzed mixture, after thinning 20% by volume with specified thinner, shall be suitable for spraying in one coat to a 10 mil wet thickness without exhibiting runs or sags.

The coating shall be suitable for application with both conventional and airless spray equipment.

710.04.1.4--Packaged Qualities. The paint shall be supplied as a two-package

material with a one-to-one mixing ratio and shall be well ground and not caked, skinned or badly settled in the container. Usable shelf life shall be not less than 12 months.

710.04.1.5--Flexibility Test. A five mil dry film thickness of paint shall be applied to one side of a 4-inch x 30-inch x 1/8-inch steel panel which has been cleaned in accordance with Steel Structures Painting Council SSPC-SP-5, Commercial Blast Cleaning. After the coating has been cured for two weeks at 75°F, it shall show no signs of cracking or loss of adhesion after the panel is uniformly bent 180 degrees (coated side out) around an eight-inch diameter pin.

710.04.1.6--Resistance Tests. A 3-inch by 5-inch by 1/8-inch test panel meeting the requirements of ASTM Designation: D 609 shall be prepared by blast cleaning in accordance with SSPC-SP-6, Commercial Blast Cleaning. After cleaning, the panels shall be exposed to the weather for 30 days to allow uniform rusting. The panels shall then be hand-cleaned with a wire brush in accordance with SSPC-SP-2.

The modified epoxy mastic paint shall be spray applied in one coat to the prepared panels with a uniform dry film thickness of six mils. Curing shall be in accordance with manufacturer's recommendations.

Each test shall be performed on one or more panels, and the paint will be unacceptable if it fails one or more of the following tests:

- (a) Salt Water Resistance. One or more panels shall be scribed with an X of at least two-inch legs down to the base metal and immersed in 5% sodium chloride at 75 ±5°F. The panel(s) shall be examined after 7, 14 and 30 days and shall show neither rusting, blistering, nor softening of the coating beyond 1/16 inch from the scribe mark. The solution shall be changed after each examining period.
- (b) Weathering Resistance. One or more panels shall be tested in accordance with ASTM Designation: G 23, Type D. The panel(s) shall be placed on test at the beginning of the wet cycle. After 1,000 hours continuous exposure, the coating shall show neither rusting, blistering, nor loss of bond.
- (c) Salt Fog Resistance. One or more panels shall be scribed with an X of at least two-inch legs down to the base metal. The panel(s) shall then be tested in accordance with ASTM Designation: B 117. After 1,000 hours continuous exposure, the coating shall show neither loss of bond, rusting nor blistering beyond 1/16 inch from the scribe mark.

710.04.2--Vinyl Finish Coat, Field Coat. The vinyl finish coat shall be manufactured by the supplier of the prime coat. The vehicle shall consist

essentially of vinyl chloride-acetate copolymer resin dissolved in aromatic or ketone and aromatic solvents. The vinyl coat shall display compatibility with, and adhesion to, the cured primer film when applied in accordance with the manufacturer's printed instructions.

710.04.2.1--Composition.

- (a) The vinyl finish coat shall be gray in color and supplied in a single package at a consistency ready for use. It shall be well ground and not caked, livered, skinned or badly settled in the container.
- (b) The vinyl finish coat shall contain not less than 29% pigment and 19% vehicle for a total of no less than 48% solids by weight. The weight per gallon shall be 9.6 ± 0.5 pounds at 77°F. The grind minimum shall be four. Any extender pigments shall be barytes.
- (c) The vinyl finish coat shall air dry at temperatures of 70°F or above to a hard tough film within four hours, entirely by evaporation of solvents. It shall be dry-to-touch in 25 minutes at 70°F.

710.04.3--Packaging. Two-component paint shall be packaged so that one unit of pigment can be mixed with the vehicle in its container. The containers for all paints shall be coated as necessary to prevent attack by the paint.

Each container shall be plainly marked with the net weight in pounds, net volume in U. S. gallons, color, code number, batch number(s), the name and address of the manufacturer and the date of manufacture. Each container, or label thereon, shall bear a true statement of the name and percentage of each component or constituent, both solid and liquid. Any package not so marked will be unacceptable.

Each shipment of paint shall be accompanied by complete written instruction and precautions for use, either on the container label or in a separate document.

710.04.4--Acceptance Procedure. Before each shipment is used, the Contractor must furnish the Engineer a certificate from the manufacturer attesting that the commercial product furnished conforms to the same formula as that previously approved.

Final acceptance will be based on results of tests performed on samples obtained by the Department prior to or after delivery. Batches of paint found not to be of the approved formulation will be rejected.

710.05--Primer for Miscellaneous Metals. The primer shall be a commercial product formulated primarily for industrial use, to combine weather durability, resistance to mildly corrosive exposures, with good film build and ease of

application with all generally used methods.

SECTION 711 - REINFORCEMENT AND WIRE ROPE

711.01--Reinforcing Steel and Wire Rope. General. All reinforcement used in concrete construction, unless otherwise stipulated, shall conform to the provisions and requirements hereinafter set out. When incorporated into the work, reinforcement shall be reasonably free of dirt, paint, oil, grease, loose-thick rust, or other foreign substances and, when deemed necessary, shall be cleaned to the satisfaction of the Engineer. Tight-thin rust or powdering rust shall not be cause to require cleaning. Reinforcement which has rusted sufficiently to cause it to fail to meet specified physical properties or prestressing strands displaying pits visible to the naked eye shall be rejected.

711.02--Reinforcing Steel.

711.02.1--Bar Reinforcement. Bar reinforcement shall conform to the requirements of AASHTO Designation: M 31, Grade 60, for billet steel bars.

Bars shall be fabricated as indicated on the plans; shall be cold-bent, unless otherwise permitted, to the shapes shown on the plans or as directed; and shall be bent prior to being wholly or partially embedded in concrete.

Unless otherwise authorized or provided on the plans, bends or hooks shall not be fabricated to a smaller diameter than that indicated for the bend test.

Rail steel bars shall be bent to the specified shapes at the mill or fabricating plant.

The areas and weights to be used in calculations for the various size reinforcing bars shall be as follows:

STANDARD REINFORCING BARS

Numbers*	Weight Pounds per Foot	Nominal Dimensions ----- Round Sections		
		Diameter Inches	Cross-Sectional Area Square Inches	Perimeter Inches
2 (1)	0.167	0.250	0.05	0.786
3	0.376	0.375	0.11	1.178
4	0.668	0.500	0.20	1.571
5	1.043	0.625	0.31	1.963
6	1.502	0.750	0.44	2.356
7	2.044	0.875	0.60	2.749
8	2.670	1.000	0.79	3.142
9 (2)	3.400	1.128	1.00	3.544
10 (2)	4.303	1.270	1.27	3.990
11 (2)	5.313	1.410	1.56	4.430
14	7.65	1.693	2.25	5.32
18	13.60	2.257	4.00	7.09

- * The bar numbers are based on the number of 1/8 inch increments in the nominal diameter of the bar, except as noted in (2) below.
- (1) No. 2 bars in plain rounds only.
 - (2) Nos. 9, 10, and 11 are round bars and equivalent in weight and nominal cross-sectional area to the old type 1-inch, 1 1/8-inch, and 1 1/4-inch square bars, respectively.

711.02.2--Bar Mats. Bar mats for concrete pavement reinforcement shall be Grade 60 billet steel, AASHTO Designation: M 31, and shall conform to the requirements of AASHTO Designation: M 54.

711.02.3--Steel Wire Fabric. Steel wire fabric shall conform to the requirements of AASHTO Designation: M 55, or AASHTO Designation: M 221.

711.02.4--Dowel Bars and Marginal Bars. Unless otherwise indicated, dowel bars used to span transverse joints and marginal bars shall be plain round bars. They shall be Grade 60 billet steel, AASHTO Designation: M 31.

Before installation, each dowel bar shall be painted with one coat of industrial grade zinc base primer, epoxy or other approved rust inhibitive primers. One half of each dowel bar shall be greased with a heavy grease equivalent to 600W or cup grease to prevent bonding with concrete. The greased end is to be inserted into the dowel bar sleeve described in the following paragraph.

Sleeves for dowel bars shall be metal or plastic of an approved design, mortar-tight, of sufficient strength to prevent collapse, and at least two inches in length.

A suitable stop shall be provided in the sleeve to permit movement of the dowel bar within the sleeve of not less than the thickness of the expansion filler used.

Dowel bars shall be free from burring or other deformations restricting slippage in the concrete.

711.02.5--Tie Bars. Unless otherwise indicated, tie bars used to span longitudinal joints shall be deformed bars, billet steel, meeting the requirements set forth in Subsection 711.02.1.

711.02.6--Cold-Drawn Steel Wire. Cold-drawn steel wire shall conform to the requirements of AASHTO Designation: M 32.

711.02.7--Supports for Bar Reinforcement. Metal bar supports shall be fabricated from stainless steel wire conforming to ASTM Designation: A 493, 16% chromium minimum, or cold-drawn wire with a minimum of 1/2 inch of the height of the leg above the form surface protected by one of the following:

Plastic coating conforming to CRSI Standards.

Galvanized, conforming to ASTM Designation: A 153, Class D.

Stainless steel conforming to ASTM Designation: A 493, 16% chromium minimum.

Other protective coating as approved by the Engineer.

Other supports as approved by the Engineer may be used.

711.02.8--Epoxy Coated Bar Reinforcement. All reinforcement bars required to be epoxy coated shall conform to the requirements of ASTM Designation: A 775. The Contractor shall furnish written certification that the coated reinforcing bars were cleaned, coated and tested in accordance with the specifications and ASTM Designation: A 775.

711.03--Reinforcement for Prestressed Concrete.

711.03.1--Pretensioning Reinforcing.

711.03.1.1--Uncoated Seven-Wire Stress Relieved Strand for Prestressed Concrete. Uncoated seven-wire stress-relieved strand for prestressed concrete shall conform to the requirements of AASHTO Designation: M 203.

711.03.1.2--Uncoated Stress-Relieved Wire for Prestressed Concrete. Uncoated stress-relieved wire for prestressed concrete shall conform to the requirements of AASHTO Designation: M 204.

711.03.2--Posttensioning Reinforcing.

711.03.2.1--Bars. Bars for posttensioning shall be of high tensile strength steel.

They shall be equipped with wedge-type anchorages which will develop the minimum specified ultimate bar stress on the nominal bar area.

The minimum physical properties of the bar steel, and of the stress-strain curve determined by static tensile tests, shall conform to the following:

Stress at 0.3% elongation, psi -----	75,000
Stress at 0.7% elongation, psi -----	130,000
Ultimate stress, psi -----	145,000
Elongation in 20 diameters, % -----	4
Modulus of elasticity, psi -----	25,000,000

The diameter tolerance of the bar steel shall be from -0.010 to +0.02375 inch.

711.03.2.2--Parallel Wire Assemblies. Wire assemblies for post-tensioning shall consist of parallel wires of the number and size shown on the plans. Wires shall conform to the requirements of AASHTO Designation: M 204. Minimum ultimate strength requirements for various sizes shall be as follows:

Diameter Inches	Minimum Ultimate Strength PSI
0.177	255,000
0.192	251,000
0.225	245,000
0.250	240,000
0.276	236,000

The stress-strain curve for wires shall show the following minimum characteristics, based on the minimum ultimate strength requirements:

Proportional limit, 0.01% offset from tangent, % -----	55
Yield point, 0.2% offset from tangent, % -----	80
Elongation at rupture -----	4% in 10 inches

The diameter tolerance of wires shall be ±0.002 inch.

711.03.3--Anchorages for Post-Tensioned Tendons.

711.03.3.1--For Bars. Wedge-type anchorages shall be used for bars. The wedge device shall develop the minimum ultimate strength specified for the nominal bar area.

Wedge anchorages shall bear against anchor plates fabricated of hot-rolled steel having physical characteristics not less than that specified for No. 104 of American Iron and Steel Institute (AISI) Specifications.

711.03.3.2--For Parallel Wire Assemblies. Wedge or direct-bearing type anchorage shall be used, generally. The anchorage device shall be capable of developing the ultimate strength of the total number of wires anchored. Conical type anchorages shall be embedded within the ends of the concrete members unless otherwise specified. Anchorages shall generally bear against grids of reinforcing steel of approved type.

711.03.3.3--Alternate Anchorage Types. Alternate anchorage types conforming to the general physical requirements for wedge or direct-bearing type anchorages will be permitted. All anchorage types shall develop the specified ultimate strength of the reinforcing tendons, or the allowable stress of the tendon will be based on the anchorage strength.

As a specific exception, threaded anchorages not on upset or oversize reinforcing ends will not be considered for approval.

Any alternate type anchorage, before being considered, will be required to show evidence of being capable of withstanding at least 3,000,000 cycles of twice the maximum live load stress variation.

711.03.4--Tests for Prestressing Reinforcing. The Engineer shall be furnished with three certified copies of test results for all tests specified below. These tests shall be performed by the manufacturer or a recognized commercial laboratory at no additional cost to the State. The Engineer or Engineer's representative shall have the privilege of witnessing any or all tests.

711.03.4.1--Strand. The physical characteristics of strand shall be determined in accordance with AASHTO Designation: M 203.

711.03.4.2--Bars.

711.03.4.2.1--Proof Test. During manufacture, each bar shall be proof tested to a minimum stress of 130,000 psi.

711.03.4.2.2--Static Test. From each mill heat, one static test shall be made on an assembled bar and anchorage to determine the physical properties of the steel and the assembly. Such physical properties shall conform to the minimum physical properties hereinbefore specified.

711.03.4.3--Wires and Wire Anchorages. One static test shall have been made from each five coils received, except that at least one static test shall have been made for each shipment. For each 500 anchorages received, or fraction thereof, one anchorage assembly shall have been tested statically to destruction.

SECTION 712 - FENCE AND GUARDRAIL

712.01-- General. Each of the several items included under this section shall be of the design, shape, size, and dimensions shown on the plans or set out in these specifications. The connections with all intersecting fences, bridges, and culvert headwalls shall be as shown on the plans.

712.02--Barbed Wire. Barbed wire shall be composed of two strands of No. 12½ gauge wire with round barbs, four-point pattern, conforming to ASTM Designation: A 121. In the coastal counties of Hancock, Harrison, and Jackson, Class 3 zinc coating shall be furnished. Class 1 or better zinc coating shall be furnished for all other areas of the State.

In lieu of the above, the Contractor may furnish high tensile strength barbed wire. If the Contractor elects to furnish high tensile strength barbed wire, it shall meet the requirements of ASTM Designation: A 121 with the following exceptions:

The coated line wires shall have a nominal diameter of 0.067 inch. The coated barbs shall have a nominal diameter of 0.057 inch.

The minimum weight of zinc coating shall be 0.75 ounce per square foot for the line wire and 0.70 ounce per square foot for the barbs.

The line wire shall have a minimum strength of 475 pounds per individual strand.

712.03--Woven Wire Fencing. Woven wire (hog wire) fencing shall conform to the requirements of ASTM Designation: A 116. In the coastal counties of Hancock, Harrison, and Jackson, Class 3 zinc coating shall be furnished. Class 1 or better zinc coating shall be furnished for all other areas of the State.

712.04--Chain Link Fence. Details will be shown on the plans or in the special provisions. Chain link fencing shall conform to the requirements of AASHTO Designation: M 181 with the following clarifications and exceptions:

Zinc coated chain link fabric for use in Hancock, Harrison, and Jackson counties shall meet the requirements for Class D spelter coating. For all other areas of the State, the spelter coating shall meet the requirements for Class C coating.

Tie wire shall conform to the requirements of Subsection 712.13.

Tension wire shall conform to the requirements of Subsection 712.14.

Posts, rails, expansion sleeves, and gate frames shall conform to the requirements for posts in Subsection 712.05.2, unless otherwise designated in

the contract.

Miscellaneous fittings and hardware shall conform to the requirements of Subsection 712.16.

The Contractor shall furnish the Engineer with manufacturer's or fabricator's test results and other data certifying that materials furnished for construction of all types of chain link fence comply with the requirements set out in these specifications. The Engineer reserves the right to retest all materials.

712.05--Fence Posts and Braces.

712.05.1--Treated Timber Posts and Braces.

712.05.1.1--General. All wood posts and braces shall be Southern Pine and shall be furnished in the sizes shown on the plans or as otherwise specified.

Insofar as practicable, each charge shall consist of pieces approximately equal in size, moisture, and sapwood content into which approximately equal quantities of preservative can be injected. Each layer of material shall be separated at each end, and at the center when necessary, by strips at least 3/8 inch in thickness.

All wood posts and braces shall be treated in accordance with AWWA C 14, except the type of preservative shall conform to Subsection 718.04. Only one type of preservative shall be used for the treatment of materials for any one class of construction on a project, unless otherwise specified.

Posts and braces will not be accepted for use unless they have been inspected by an authorized representative of the Department and found to be satisfactory both before and after treatment. Inspection prior to treatment may be waived by the State Materials Engineer when the preservative will be pentachlorophenol or chromated copper arsenate.

Inspection for conformance to these specifications will be conducted in accordance with Department Standard Operating Procedures. Borer cores for determining the amount of preservative retained and the penetration of preservative will be obtained in accordance with Standard M2. The test method for determining the amount of preservative retained will be either as specified in AWWA or Mississippi Test Methods. All borings shall be taken at the center of the narrow side of the piece. Test holes shall be plugged with treated plugs. If 20% or more of the borings from a charge of treated material fail to meet the penetration requirements, the entire charge shall be rejected and subject to retreatment. If upon retreatment, the material meets the penetration requirements it will be accepted provided all other characteristics conform to the specifications. Only one retreatment will be permitted, and any apparent damage due to retreatment shall be cause for rejection.

The Department shall be notified sufficiently in advance of treating the material so that an inspector may be furnished at the plant to inspect the material and the treatment of same. All materials and processes used in the manufacture of the materials shall be subject to inspection. The plant shall be equipped with the necessary gauges, thermometers, appliances, and facilities to enable the inspector to determine the conditions at all stages of the treatment and to satisfy the inspector that the requirements of the specifications are fulfilled. The manufacturer shall also provide the apparatus and chemicals necessary for making tests at the plant as required by the Department. All equipment, apparatus, etc., shall be maintained in proper and satisfactory condition for use at all times.

712.05.1.2--Round Posts. Unless otherwise indicated, wood line posts shall be round, shall be cut from sound and solid trees, and shall be free from short or reverse bends in more than one plane. A straight line from center of tip to center of butt shall not deviate outside the post. Posts shall be free of ring shake, season cracks more than 1/4 inch wide, splits in the end, and unsound knots. Sound knots will be permitted provided the width of the knot does not exceed 1/3 the diameter of the post at the point where it occurs. Groups of knots or any combination of defects impairing the strength more than the maximum size knot will not be permitted. The posts shall show not less than three annual rings per inch, and not less than 30% of summer wood.

The size of round posts will be specified in even inches of diameter at the top (smaller) end and shall not vary more than 1/2 inch from the specified diameter; i.e., nominal four-inch posts may vary between 3 1/2 inches and 4 1/2 inches; nominal six-inch posts may vary between 5 1/2 inches and 6 1/2 inches. This diameter shall be determined from the circumference after peeling. In the case of ovate (not true round) posts, the maximum diameter shall not be more than 20 percent greater than the minimum diameter, direct measure. The maximum allowable increase of diameter at the butt shall be at the rate of 1 1/2 inches in 10 feet. A tolerance of ± 2 inches will be allowed in the specified length.

Prior to treatment, round posts shall be machine peeled for their full length, with all bark and inner skin removed and all knots or projections trimmed flush with the surface of the surrounding wood. The ends shall be sawed square. Treatment shall be in accordance with AWP Standard C14.

712.05.1.3--Sawed Posts. Sawed fence posts shall conform to the shape and nominal dimensions shown on the plans. They shall be No. 1 or better, graded in accordance with American Lumber Standards. Treatment will be in accordance with AWP Standard C14.

712.05.1.4--Sawed Braces. Sawed braces shall conform to the shape and nominal dimensions shown on the plans. They shall be No. 1 or better, graded in accordance with American Lumber Standards. Treatment will be in accordance

with AWP Standard C14.

712.05.2--Metal Posts. All metal posts shall be of the size and configuration specified on the plans.

712.05.2.1--Round Steel Posts. Round steel posts shall be galvanized steel pipe, coated inside and out, meeting the requirements of ASTM Designation: F 1083. Schedule 40 shall be applicable unless otherwise specified in the contract. Round steel posts meeting the following specifications will be acceptable alternates to those meeting the requirements of ASTM Designation: F 1083, Schedule 40.

712.05.2.1.1--Method of Manufacture. The pipe shall be manufactured by cold rolling electric resistance welding of high strength steel having a minimum yield strength of 50,000 psi conforming to ASTM Designation: A 653 or A 1011. The exterior surface of the pipe shall be triple coated with hot-dip galvanized zinc followed by a chromate conversion coating and a urethane or polyurethane acrylic top coating. The interior surface of the pipe shall be given corrosion protection by zinc rich organic coating or a hot-dipped galvanized zinc coating.

712.05.2.1.2--Pipe Size and Weight. The pipe shall meet the following nominal requirements for outside diameter, wall thickness and weight per linear foot:

NPS Designator Inside Diameter	Outside Diameter	Wall Thickness	Weight per foot
<u>Inches</u>	<u>Inches</u>	<u>Inches</u>	<u>pounds</u>
1¼	1.660	0.110	1.820
1½	1.900	0.120	2.281
2	2.375	0.130	3.117
2½	2.875	0.160	4.640

NOTE: Allowable tolerances from the above dimensions and weight per foot are as follows:

Outside Diameter:	±1.0%
Wall Thickness:	-5.0%, No limit on plus
Weight per Foot:	±5.0%

712.05.2.1.3--Pipe Strength. The strength of the pipe shall be the product of the yield strength and the section modulus, and shall not be less than that of pipe of equivalent diameter conforming to ASTM Designation: F 1083, Schedule 40.

712.05.2.1.4--Protective Coatings. The protective coatings shall conform to the requirements of AASHTO Designation: M 181 for Grade 2 posts and rails with hot-dip galvanized zinc plus organic exterior coatings.

712.05.2.2--Steel Tee Posts. Steel tee posts shall meet the requirements of

ASTM Designation: A 702, galvanized in accordance with the requirements of ASTM Designation: A 123.

Acceptance of the steel posts shall be by certification from the manufacturer, producer, supplier, or fabricator, as applicable.

712.05.2.3--Steel H-Beam Posts. Steel H-Beam posts shall be produced from structural quality weldable steel having a minimum yield strength of 45,000 psi and shall be galvanized in accordance with ASTM Designation: A 123. Steel H-Beam line posts shall be 2.250 inches by 1.625 inches and shall weigh 3.43 pounds per foot. A tolerance of plus or minus 5.0 percent is allowed for weight per foot. A tolerance of plus or minus 1.0 percent is allowed for dimensions.

712.05.2.4--Aluminum-Alloy Posts. Round aluminum-alloy posts shall meet the requirements of ASTM Designation: B 241, Alloy 6061, T6.

Aluminum-Alloy H-Beam posts shall meet the requirements of ASTM Designation: B 221, Alloy 6061, T6.

712.05.2.5--Formed Steel Section Posts. Formed steel section posts, "C" sections, shall be formed from sheet steel conforming to ASTM Designation: A 1011, Grade 45, and shall be galvanized in accordance with ASTM Designation: A 123. The posts shall meet the dimensions and weight per linear foot set-out below. A tolerance of plus or minus 5.0 percent is allowed for weight per foot. A tolerance of plus or minus 1.0 percent is allowed for dimensions.

<u>Size, Inches</u>	<u>Weight, Pounds Per Foot</u>
1.625 X 1.250	1.35
1.875 X 1.625	1.85
2.250 X 1.700	2.78
3.500 X 3.500	5.10

712.05.3--Concrete Posts.

712.05.3.1--Manufacture. Concrete posts shall be manufactured in accordance with the details shown on the plans and shall conform to the requirements hereinafter set forth. Posts shall receive a Class 1 finish as noted in Subsection 804.03.19. Where indicated on the plans, holes and bolts shall be accurately cast in the members at the time of pouring. Posts shall be cured at least seven days.

712.05.3.2--Materials. The materials used in the manufacture shall conform to the following:

Cement shall meet the requirements of Section 701.

Aggregates shall meet the requirements of Subsections 703.02 and 703.03, except that the requirements for gradation are not applicable.

Reinforcing steel shall meet the requirements of Section 711.

The concrete shall have a minimum cement factor of 1.25, or five bags of cement to a cubic yard of concrete.

712.05.3.3--Strength Requirements. The strength of concrete posts shall be determined by the beam method. When loaded at the midpoint of an 18-inch span with three edge bearing, the unit shall develop at least 6,000 pounds total load for a four-inch by four-inch post; or 12,000 pounds total load for a six-inch by six-inch post.

Two specimens will be tested for each 200 posts, one to destruction and one to the ultimate load specified above.

712.06--Guard and Guardrail Posts.

712.06.1--General. Unless otherwise specified, guardrail posts may be either wood or steel, and guard posts may be either wood, steel, or concrete. All guardrail and guard posts materials shall conform to the dimensions and requirements as shown on the plans or as set out in these specifications.

712.06.2--Treated Wood Posts. Treated wood posts shall conform to the size and dimensions as shown on the plans and as hereinafter specified.

712.06.2.1--Square Posts. All square posts shall be inspected in accordance with Section 718 except that the posts may be rough and shall be within $\pm 3/8$ " of the dimensions shown on the plans. Treatment will be in accordance with AWWA Standard C14.

712.06.2.2--Round Posts. All round posts shall be inspected and treated in conformity with 712.05.1 and shall be of the shape and dimensions as shown on the plans.

712.06.3--Concrete Posts. Concrete posts shall conform to the requirements of Subsection 712.05.3.

712.06.4--Steel Posts. Steel posts shall be of the section and length as shown on the plans and shall conform to the requirements of ASTM Designation: A 36.

The posts shall be galvanized or shop-painted as specified.

712.06.5--Treated Wood Blocks For Use With Metal Guardrail Posts. Treated wood blocks for use with metal guardrail posts shall be within $\pm 3/8$ -inch

of the size and dimensions shown on the plans, except that a minus tolerance shall not be allowed for the slotted width in which the metal post must fit. Preservative treatment shall be in accordance with AWWA Standard C14.

The blocks must be obtained from approved manufacturers listed on MDOT's "Approved Sources of Materials" for suppliers of treated wood products. The manufacturer's approval will be based on their Quality Control Program for material certification. The manufacturer shall employ a certified material grader and treatment inspector who will be responsible for grading and inspecting the treated material. The inspector's certification shall be from an approved industrial organization such as AWWA, SPIB or American Lumber Standard. The manufacturer's certification shall be based on satisfactory grading, dimensional measurements, and treatment results. The manufacturer shall provide the Contractor two copies of their material certification and treatment report for each charge of material delivered. Also, a copy of these documents shall be mailed to the State Materials Engineer for all blocks shipped for use on MDOT projects.

The manufacturer shall brand each block with the following information:

- (1) manufacturer's logo or initials (XYZ)
- (2) manufacturer's plant location
- (3) species of wood (SYP)
- (4) treatment type (CCA-C)
- (5) minimum preservative retention by assay (0.50)

The Contractor, prior to installation of the blocks, shall furnish a copy of the manufacturer's certification and treatment report covering the blocks to be installed to the Department's representative.

The Project Engineer, or the Project Engineer's designated representative, will inspect each block prior to installation for proper dimensions, identification and damage or other deficiency prior to permitting installation of the blocks. The Project Engineer will notify the State Materials Engineer when blocks are delivered to the project and report any deficiencies found. The State Materials Engineer will, at the State Materials Engineer's discretion, dispatch an inspector to the project for inspecting and boring the blocks for an assay test. Final acceptance of the blocks will be based on satisfactory field inspection and satisfactory test results when field sampling is performed.

712.07--Metal Rail. Metal rail for guardrail shall conform to the requirements of AASHTO Designation: M 180 and as specified on the plans.

712.08--Timber Rail. Timber rail shall conform to the requirements of Section 718 and as specified on the plans.

712.09--Guardrail Hardware. Guardrail hardware such as bolts, nuts and washers shall conform to the requirements of ASTM Designation: A 307 except specified bolts, as shown on the plans, shall meet the requirements of ASTM Designation: A 325 or AASHTO Designation: M 164. Galvanizing may be hot-dipped or by a mechanical method all in accordance with ASTM Designation: A 153, except for method of coating.

712.10--Box Beam Rail. Steel beam rail elements shall conform to the requirements of ASTM Designation: A 500 or ASTM Designation: A 501 and shall be galvanized after fabrication in accordance with AASHTO Designation: M 111, except when corrosion resistant steel rail elements are specified; in which case rail elements shall be made of steel meeting the dimensional and mechanical requirements of ASTM Designation: A 500 or ASTM Designation: A 501, shall have an atmospheric corrosion resistance approximately two times that of carbon structural steel with copper, and shall not be painted or galvanized. Posts shall conform to Subsection 712.06 and hardware to Subsection 712.09.

712.11--Guardrail Cable and Anchorage. Cable shall meet the requirements of AASHTO Designation: M 30 for Type II wire rope.

The anchor rod shall be fabricated of steel conforming to the requirements of ASTM Designation: A 36. The eye may be drop forged or formed with a full penetration weld and shall develop 100 percent of the rod strength.

The swaged fitting and stud assembly shall be of steel conforming to the requirements of ASTM Designation: A 576, Grade 1035 and shall be annealed and suitable for cold swaging. The fitting shall be galvanized in accordance with ASTM Designation: A 123 before swaging. The studs shall conform to the requirements of ASTM Designation: A 449 and shall be galvanized as set forth for guardrail hardware. The swaged fitting, stud and nut shall develop the breaking strength of the wire rope. Three certified copies of the manufacturer's certificate attesting to the strength of the swage fittings shall be furnished the State Materials Engineer.

712.12--Gates.

712.12.1--Slatted Aluminum Gates. Slatted aluminum gates shall be of the design and dimensions as shown on the plans. Members, parts, and accessories shall be formed of an aluminum alloy having a high resistance to corrosion. Minimum nominal thickness of members shall be 0.051 inch for horizontals and 0.040 inch for diagonals and verticals.

Aluminum gates shall be tightly riveted construction and after erection shall not show any sag or warp. The gates shall be equipped with satisfactory hinge supports and latch or aluminum chain with steel snap.

712.12.2--Galvanized Ferrous Metal Gates. Galvanized ferrous metal gates shall be of the design and dimensions as shown on the plans. The gates shall be fabricated from 24-gauge or heavier metal with rigid construction, and after erection the gates shall not show any sag or warp. Steel sheets used in fabricating gates shall be hot dip galvanized in accordance with ASTM Designation: A 653, G 60 Coating Designation.

712.12.3--Aluminum-Zinc Alloy Coated Metal Gates. Aluminum-zinc alloy metal gates shall be of the design and dimensions as shown on the plans. The gates shall be fabricated from 24-gauge or heavier metal with rigid construction, and after erection the gates shall not show any sag or warp. Steel sheets used in fabricating gates shall be coated with an aluminum-zinc alloy by the hot-dip process. The coating shall have a nominal chemical composition of 55.0% aluminum, 43.4% zinc and 1.6% silicon. The chemical analysis of the coating shall agree with the nominal composition within $\pm 3\%$ for aluminum and zinc, and within $\pm 0.5\%$ for silicon. The minimum weight of coating shall be 0.5 ounce per square foot total both sides when tested in accordance with AASHTO Designation: T 65.

712.12.4--Aluminum Coated Metal Gates. Aluminum coated metal gates shall be of the design and dimensions as shown on the plans. The gates shall be fabricated from 24-gauge or heavier metal with rigid construction, and after erection shall not show any sag or warp. Steel sheets used in fabricating gates shall be coated with aluminum by the hot-dip process. The coating shall meet the chemical requirements of AASHTO Designation: M 274. The minimum weight of coating shall be 0.4 ounce per square foot total both sides when tested in accordance with AASHTO Designation: T 213.

712.12.5--Fabric Filled Gates. The gate frame shall be constructed from pipe meeting the requirements of ASTM Designation: F 1083, Schedule 40, and to the design and dimensions as shown on the plans. All connections shall be welded and watertight. The entire frame shall be hot dip galvanized after welding.

712.12.6--Acceptance Procedure. The Contractor shall furnish the Engineer three copies of the manufacturer's certification attesting that the gates furnished comply with the requirements of the contract.

712.13--Tie Wire. Tie wire shall be of good commercial quality zinc coated steel, aluminum coated steel or aluminum alloy of the size and spacing shown on the plans. Zinc coated steel wire shall meet the spelter coating requirements of AASHTO Designation: M 279, Class 1. Aluminum coated steel wire shall be coated with aluminum meeting the requirements of AASHTO Designation: M 181 and at the rate of not less than 0.4 ounces per square foot of uncoated area.

712.14--Tension Wire. Tension wire shall be of the same material as the fencing wire being used, shall be of good commercial quality, and shall meet the

following requirements for the specified type wire being used.

712.14.1--Zinc Coated Tension Wire. The base metal of zinc coated tension wire shall be steel wire having a minimum tensile strength of 60,000 psi and shall meet the spelter coating requirements of AASHTO Designation: M 279, Class 1.

712.14.2--Aluminum Coated Tension Wire. The base metal of aluminum coated tension wire shall be steel wire having a minimum tensile strength of 60,000 psi and shall be coated with aluminum meeting the requirements of AASHTO Designation: M 181 for aluminum coating and at the rate of not less than 0.4 ounces per square foot of uncoated area.

712.14.3--Aluminum Alloy Tension Wire. Aluminum alloy tension wire shall have a minimum tensile strength of 42,000 psi.

712.15--Staples. Unless otherwise specified, staples shall be made of 9-gauge galvanized steel wire and shall be of the shape and size shown on the plans. The galvanizing shall be commercial quality uniformly applied zinc coating.

712.16--Hardware. All ferrous metal hardware for fencing such as bolts, nuts, washers, and metal straps shall be as specified on the plans and galvanizing shall not be less than 1.0 ounce per square foot of uncoated area. Aluminum coated hardware shall be coated with aluminum meeting the requirements of AASHTO Designation: M 181 for aluminum coating and at the rate of not less than 0.4 ounces per square foot of uncoated area.

Aluminum alloy hardware shall conform to the requirements of ASTM Designation: B 221 for extruded aluminum alloy 6063, T6. The finished members shall be of uniform quality.

Aluminum-zinc coated hardware shall be coated with an aluminum-zinc alloy meeting the chemical requirements and weight of coating specified for aluminum-zinc alloy coated metal gates.

SECTION 713 - CONCRETE CURING MATERIALS AND ADMIXTURES

713.01--Curing Materials. Concrete curing agents, including water and earth, shall be free of any ingredients which may damage or be detrimental to the concrete. Such agents, unless otherwise specified, shall conform to the requirements hereinafter set forth.

713.01.1-Burlap Cloth. Burlap to be used for curing concrete shall conform to the requirements of AASHTO Designation: M182.

Class 3 burlap shall be used by placing one or two layers as required. The substitution of other classes may be made, provided their combined weight will equal or exceed the weight required.

713.01.2--Liquid Membrane Compound. Membrane-forming compound for curing concrete shall conform to the requirements of AASHTO Designation: M 148.

Unless otherwise specified, only Type 2, White Pigmented, will be permitted for use.

The use of liquid membrane for curing concrete surfaces which are to have a rubbed finish or faces of construction joints will not be permitted.

713.01.3--Polyethylene Sheeting. White polyethylene sheeting shall conform to the requirements of AASHTO Designation: M 171 for white opaque polyethylene film.

713.02--Admixtures for Concrete. Air-entraining admixtures used in portland cement concrete shall comply with AASHTO Designation: M 154. Set-retarding, accelerating, and/or water-reducing admixtures shall comply with AASHTO Designation: M 194.

In order to obtain approval of an admixture, the State Materials Engineer shall have been furnished certified test reports, made by an acceptable independent laboratory regularly inspected by the Cement and Concrete Reference Laboratory of the National Bureau of Standards, which show that the admixture meets all the requirements of the applicable AASHTO Standard Specification.

The Department reserves the right to sample, for check tests, any shipment or lot of admixture delivered to a project.

The Department reserves the right to require tests of the material to be furnished, using the specific cement and aggregates proposed for use on the project, as suggested in AASHTO Designation: M 154 and outlined in AASHTO Designation: M 194.

After an admixture has been approved, the Contractor shall submit to the State Materials Engineer, with each new lot of material shipped, a notarized certification from the manufacturer showing that the material is of the same composition as that originally approved, and that the material has not been in any way changed or altered.

Admixtures containing chlorides will not be permitted.

Failure to maintain compliance with any requirement of these specifications shall be cause for rejection of any previously approved source or brand of admixture.

When an admixture is used in portland cement concrete, it shall be the responsibility of the Contractor to produce satisfactory results.

SECTION 714 - MISCELLANEOUS MATERIALS

714.01--Water.

714.01.1--General. All water used shall be free from injurious quantities of oil, acid, alkali, or vegetable matter; shall be reasonably clear; and shall not be brackish. If at any time water from source becomes of unsatisfactory quality or of insufficient quantity, the Contractor shall provide satisfactory water from some other source. Where the source of water is relatively shallow, the Engineer may require the intake to be so enclosed as to exclude silt, mud, grass, or other foreign materials.

Requirements for impurities set out in these specifications are general maximums which may be used as a basis for acceptance. However, if the preliminary analysis indicates that any of the specified limits for acidity or alkalinity, organic solids, or inorganic solids are exceeded, the water may be further tested as provided in Subsection 714.01.6 to determine its suitability for the purpose intended.

714.01.2--Water for Use in Concrete. Water used in mixing of concrete, mortar, and grout shall be as set out above. In addition, the water shall not contain impurities in excess of the following limits:

Acidity or alkalinity, calculated in terms of calcium carbonate, % -----	0.05
Total organic solids, % -----	0.05
Total inorganic solids, % -----	0.05

The tests for organic solids and inorganic solids may be waived by the State Materials Engineer on water samples from ponds, lakes, streams, rivers, and ditches in all except the following counties: Pearl River, Stone, George, Hancock, Harrison, and Jackson Counties.

714.01.3--Water for Use in Chemically Stabilized Base. Water used in the construction of bases which contain cement, lime, or other chemical additive shall be as set out in Subsection 714.01.1 and, in addition, shall not contain impurities in excess of the following limits:

Acidity or alkalinity, calculated in terms of calcium carbonate, % -----	0.05
Total organic solids, % -----	0.05
Total inorganic solids, % -----	0.20

The tests for organic solids and inorganic solids may be waived by the State

Materials Engineer on water samples from ponds, lakes, streams, rivers, and ditches in all except the following counties: Pearl River, Stone, George, Hancock, Harrison, and Jackson Counties.

714.01.4--Water for Use in Granular Base. Water for use in granular bases may be brackish.

714.01.5--Water for Use in the Planting and Establishment of Vegetation. Water used for planting and establishment of vegetation shall meet the requirements of Subsection 714.01.1 as related to injurious quantities of oil, acid, or alkali and shall not be brackish.

714.01.6--Tests. As applicable, a routine analysis of the sample of water submitted will be made. If the routine analysis indicates that any of the specified limits for acidity or alkalinity, organic solids, or inorganic solids are exceeded, the water may be further tested by either or both of the following methods as determined by the State Materials Engineer:

1. A chemical analysis to determine the nature of the specified characteristics for which minimum values are established.
2. Strength and Time-of-Set Test. Results of additional tests may be considered satisfactory if:
 - (a) the solids are found to be not detrimental to the materials with which the water is used;
 - (b) the alkali carbonates and bicarbonates do not exceed 0.1% by weight of water when the combination of carbonates and bicarbonates is calculated to sodium carbonate, Na_2CO_3 ;
 - (c) the 28-day strength of mortar made with the water is not less than 90% of that made with distilled water; and
 - (d) the time of set is not less than 45 minutes.

In general, water will be approved if it complies with the applicable requirements of the Standard Specifications, or if the results of additional tests as provided above are determined by the State Materials Engineer to be satisfactory.

No formal tests of water used for granular base, or embankment construction, or in connection with the planting and establishment of vegetation will be made unless the Engineer questions the quality of the water.

714.02--Calcium Chloride. Calcium chloride shall conform to the requirements of AASHTO Designation: M 144. Calcium chloride shall not be used in concrete which will be prestressed; nor shall it be used in other concrete unless specifically approved by the Engineer.

714.03--Lime.

714.03.1--General. Lime shall be stored and handled in closed, weather-proof containers until used. If local storage is provided, lime shall be used only from approved storage facilities and shall meet the requirements of the contract at the time of use.

714.03.2--Hydrated Lime. Hydrated lime for use in mortar shall conform to the requirements of ASTM Designation: C 207, Type N.

Hydrated lime for soil stabilization shall conform to the following requirements:

Calcium and magnesium oxides, nonvolatile basis, %, minimum -----	90
Carbon dioxide, %, maximum -----	7
Moisture loss, 2 hours @ 120°C, maximum -----	3

Gradation of Residue:	
Retained on No. 30 sieve, %, maximum -----	2.5
Retained on No. 200 sieve, %, maximum -----	15

714.03.3--Quick Lime.

714.03.3.1--Granular or Pelletized Quick Lime. Granular or pelletized quick lime for soil stabilization shall be a commercial granular or pelletized quick lime and shall conform to the following requirements prior to slaking:

Calcium and magnesium oxides, nonvolatile basis, %, minimum -----	90
Carbon dioxide, %, maximum -----	7
Gradation, percent passing by weight:	
¾ inch sieve -----	100
No. 4 sieve -----	0-30

The Contractor shall furnish certified test reports with each shipment of quick lime attesting to the purity of the lime and that the lime meets the requirements of the specifications; however, the material shall be subject to inspection, test, or rejection by the Engineer at any time

714.03.3.2--Dry Quick Lime. Dry quick lime used for soil stabilization by the dry application method shall be a commercial quick lime and shall conform to the following requirements after two minutes on a Ro-tap shaker:

<u>Sieve</u>	<u>Percent Passing By Weight</u>
No. 10	100
No. 20	90 - 100
No. 100	0 - 20
No. 200	0 - 5

Dry quick lime shall meet the slaking standards as defined in ASTM Designation: C 110, and shall reach maximum heat rise in no more than six (6) minutes.

The Contractor shall furnish certified test reports with each shipment of quick lime attesting to the purity of the lime and that the lime meets the requirements of the specifications; however, the material shall be subject to inspection, test, or rejection by the Engineer at any time.

714.03.4--Bag Lime. When bag lime is used, the bag shall bear the weight certified by the manufacturer. Bags varying more than five percent from the certified weight will be rejected, and the average weight of bags in any shipment determined by weighing 50 bags taken at random shall not be less than the certified weight. Bag lime shall conform to the requirements of hydrated or quick lime as applicable.

714.03.5--Limestone Dust. The source of the material shall be approved by the Engineer and meet the following gradation requirements:

<u>Sieve</u>	<u>Percent Passing</u>
No. 30	95 - 100
No. 200	20 - 100

714.04--Sodium Chloride. Sodium chloride shall conform to the requirements of AASHTO Designation: M 143.

714.05--Fly Ash.

714.05.1--General. The fly ash source must be approved for listing in the Department’s “Approved Sources of Materials” prior to use. The acceptance of fly ash shall be based on certified test reports, certification of shipment from the supplier and tests performed on samples obtained after delivery in accordance with the Department SOP.

Different classes of fly ash or different sources of the same class shall not be mixed or used in the construction of a structure or unit of a structure without written permission from the Engineer.

The Contractor shall provide suitable means for storing and protecting the fly ash from dampness. Fly ash which has become partially set or contains lumps of caked fly ash shall not be used.

The temperature of the bulk fly ash shall not be greater than 165° at the time of incorporation into the work.

In addition to these requirements, fly ash shall meet the following specific

requirements for the intended use.

714.05.2-Fly Ash for Use in Concrete. When used with portland cement in the production of concrete or grout, the fly ash shall meet the requirements of AASHTO Designation: M 295, Class C or F, with the following exceptions:

The loss on ignition shall not exceed 6.0 percent.

The pozzolanic activity index with portland cement shall be at least 55 percent of the control mix at seven days. The water requirement shall not exceed 105 percent of the control mix.

Fly ash shall not be used with portland cement Type IP.

714.05.3-Fly Ash for Soil Stabilization. When used with hydrated lime in soil stabilization, the class of fly ash shall be as specified in the contract. The fly ash, when mixed with hydrated lime and soil or soil-aggregate, shall produce the minimum design characteristics for the course to be stabilized. The fly ash shall meet the requirements of AASHTO Designation: M 295 for the class specified, except the loss on ignition shall not exceed 10.0 percent.

714.06--Ground Granulated Blast Furnace Slag (GGBFS).

714.06.1--General. The GGBFS source must be approved for listing in the Department's "Approved Sources of Materials" prior to use. The acceptance of GGBFS shall be based on certified test reports, certification of shipment from the supplier and tests performed on samples obtained after delivery in accordance with the Department's Standard Operating Procedures.

The Contractor shall provide suitable means for storing and protecting the GGBFS against dampness and contamination. Separate storage silos, bins or containers shall be provided for GGBFS. GGBFS which has become partially set, caked or contains lumps shall not be used.

The Engineer shall be notified in writing of the nature, amount and identity of any processing or other additions made to the GGBFS during production.

GGBFS from different mills shall not be mixed or used alternately in any one class of construction or structure without written permission from the Engineer; except that this requirement will not be applicable to cement treatment of design soils or bases.

In addition to these requirements, GGBFS shall meet the following specific requirements.

714.06.2--Specific Requirements. GGBFS shall meet the requirements of

AASHTO Designation: M 302, Grade 100 or 120. GGBFS shall contain no chlorides.

714.07--Blank.

714.08--Frames, Grates, Covers, and Ladder Rungs. Metal units shall conform to the plan dimensions and to the applicable requirements in Sections 716 or 717.

Galvanizing, where specified for these units, shall conform to the requirements of AASHTO Designation: M 111, unless otherwise designated.

714.09--Blank.

714.10--Elastomeric Bearings.

714.10.1--General. This work shall consist of furnishing and installing elastomeric bearings in accordance with the plans and these specifications. All required testing and furnishing of sample bearings is considered to be part of the covered work. Shop drawings shall be approved by the Engineer prior to beginning of fabrication or production of bearings.

Elastomeric bearings, as herein defined, shall include plain or nonreinforced pads consisting of elastomer only, and reinforced or laminated bearings consisting of elastomer reinforced with steel laminates.

All elastomeric bearings shall be furnished to the dimensions indicated on the plans. They shall be composed of the specified elastomer type, grade and hardness or shear modulus; shall be adequate for the specified design load; shall be tested at the appropriate level; and shall satisfy any special requirements as shown on the plans.

714.10.2--Elastomer. The raw elastomer shall be virgin polychloroprene (Neoprene), Grade 3 as referenced in ASTM Designation: D 4014.

Elastomer for plain or nonreinforced bearings shall be 70-Durometer, adequate for 800 pounds per square inch design compression stress, and shall be tested to Level I as hereinafter described.

Unless otherwise shown on the plans, elastomer for laminated or reinforced bearings shall be 50-Durometer, adequate for 1,000 pounds per square inch design compression stress, and shall be tested to Level I as hereinafter described.

An elastomer of higher grade number may be substituted for the specified grade.

The elastomer compound shall also meet the minimum requirements of Table I

except as otherwise specified by the Engineer. When test specimens are cut from the finished product, a 10 percent variation in physical properties shall be permitted. All material tests shall be carried out at $73 \pm 4^{\circ}\text{F}$ unless otherwise specified.

TABLE I

Material Property	ASTM Designation	Test Requirements	Polychoroprene			Units
			50 Duro	60 Duro	70 Duro	
Physical Properties	D 2240 D 412	Hardness	50 ±5	60 ±5	70 ±5	Shore A Pts.
		Minimum tensile strength	2250	2250	2250	psi
		Minimum ultimate elongation	400	350	300	%
Heat Resistance at specified temperature	D 573	Specified temperature of the test for 22 hours	212	212	212	°F
		Aging time	70	70	70	Hours
		Maximum change in durometer hardness	+15	+15	+15	Shore A Pts.
		Maximum change in tensile strength	-15	-15	-15	%
		Maximum change in ultimate elongation	-40	-40	-40	%
Compression Set at specified temperature	D 395 Method B	Specified temperature of test degrees	212	212		°F
		Maximum permissible set	35	35	35	%
Ozone Resistance	D 1149	Partial pressure of ozone during test	50	50	50	mPa
		Duration of test	100	100	100	Hours
		Tested at 20% strain 100 ±2°F mounting	no cracks	no cracks	no cracks	
		procedure D518, Procedure A				

(Continued on next page)

TABLE I - (Continued)

Material Property	ASTM Designation	Test Requirements	Polychoroprene			Units
			50 Duro	60 Duro	70 Duro	
Low Temperature	D 2137 Method A	Low temperature Brittleness Test required for Grade 3 and 5 only at -13°F for Grade 3 and -40°F for Grade 5	no failure	no failure	no failure	
	D 1415 or D 2240	Low temperature stiffness required for Grades 2, 3 and 5 only. Conditioned for 22 hours at 14°F for Grade 2, 13°F for Grade 3 and -40°F for Grade 5. Maximum change in hardness	+15	+15	+15	Shore A Pts.
	D 1229	Maximum low temperature compression set required for Grades 2, 3 and 5 only when tested at 25% compression for: 22 hours at 32°F for Grade 2, 7 days at 14°F for Grade 3, 14 days at each of 14°F and -13°F for Grade 5.	65	65	65	%

714.10.3--Steel Laminates. Steel laminates used for reinforcement shall be made from rolled mild steel conforming to ASTM Designation: A 36 or A 1011, unless otherwise specified by the Engineer. The laminates shall have a minimum nominal thickness of 16-gauge. Holes in plates for manufacturing purposes shall be considered in design.

714.10.4--Bonding Adhesive. The vulcanized bond between the elastomer and steel laminates shall have a minimum peel strength of 40 pounds per inch. The peel strength shall be performed in accordance with ASTM Designation: D 429, Method B.

714.10.5--Fabrication.

714.10.5.1--General. Plain pads shall be cast as a single unit in individual molds under heat and pressure except leveling pads 3/8 inch or less in thickness may be sheared. Bearings with steel laminates shall be cast as a unit in a mold and bonded and vulcanized under heat and pressure. The molds shall have standard shop practice mold finish. The internal steel laminates shall be sandblasted and cleaned of all surface coating rust and mill scale before bonding, shall be free of sharp edges and burrs, and shall have a minimum edge cover of 1/8 inch.

Flash tolerance, finish, and appearance shall meet the requirement of the latest edition of the Rubber Handbook as published by the Rubber Manufacturers Association, Inc., RMA F3 and T.063 for molded bearings and RMA F2 for extruded bearings.

714.10.5.2--Tolerances. Plain pads and laminated bearings shall be built to the design dimensions and these specifications with the following tolerances:

- (a) Overall Vertical Dimensions
 - Design Thickness 1¼ inches or less -0, +1/8"
 - Design Thickness >¼ inches -0, +1/4"
- (b) Overall Horizontal Dimensions
 - 36 inches and less -0, +1/4"
 - over 36 inches -0, +1/2"
- (c) Thickness of Individual Layers of Elastomer
 - Laminated Bearings Only at any point within the bearing ±20% of design value but no more than ±1/8"

(d) Variation from a Plane Parallel to the Theoretical Surface as determined by Measurements at the edge of the bearings	
Top	slope relative to the bottom of no more than .005 radians
Sides	1/4"
(e) Position of Exposed Connection Members	1/8"
(f) Edge cover of Embedded Laminates or Connection Members	-0, +1/8"
(g) Size of Holes, Slot or Inserts	±1/8"
(h) Position of Holes, Slots, or Inserts	±1/8"

714.10.6--Acceptance Procedure. The acceptance criteria shall be at two levels. Level I acceptance shall be applied to all elastomeric bearings. Level II acceptance criteria shall be applied as required on the plans or contract documents. Level II criteria shall also be used to resolve differences over the acceptance of bearings to which only Level I tests have been applied.

Level I criteria require that bearing pads be manufactured according to this specification and any additional requirements specified on the plans. The manufacturer shall proof load each steel reinforced bearing with a compressive load of 1500 pounds per square inch. If bulging patterns imply laminate placement which does not satisfy design criteria and manufacturing tolerances or if bulging suggests poor laminate bond, the bearing shall be rejected. If there are three (3) separate surface cracks which are greater than 0.08-inch wide and 0.08-inch deep, the bearing shall be rejected.

A copy of the proof loading results for each lot of steel reinforced bearings shall be furnished the Bridge Engineer prior to shipment of the bearings.

The Department reserves the right to require that proof loading be done in the presence of and witnessed by a representative of the Department. Whether a Department representative was present to witness the proof loading or not, the manufacturer's certification concerning compliance with the requirements of the contract shall attest to acceptable proof loading.

Level I criteria require that the elastomer satisfy the minimum properties of Table I. Level I criteria also include bond test for laminated bearings as referenced in ASTM Designation: D 429, Method B.

Level II certification requires that all Level I conditions be satisfied, except that individual condition may be waived by the Engineer if Level II certification is used as an arbitration of disputes. Additionally, shear modulus and compressive stiffness shall be determined in accordance with ASTM Designation: D 4014. The shear modulus shall fall within the range of values specified in Table II. Compressive stiffness tests shall be performed on the complete bearing. The compressive stiffness shall vary by no more than ± 10 percent from the median value of all bearings.

TABLE II

HARDNESS (SHORE A)	50	60	70
Shear Modulus at 73°F, psi	85 - 100	120 - 155	160 - 200

The Contractor shall furnish to the Engineer three copies of the manufacturer's certified test reports and certification that each lot in a shipment complies with the requirements of the contract.

714.10.7--Marking. Each reinforced bearing shall be marked in indelible ink or flexible paint. The marking shall consist of the order number, lot number, bearing identification number, and elastomer type and grade number. Unless otherwise specified in the contract documents, the marking shall be on a face which is visible after the erection of the bridge.

714.10.8--Sampling. A lot for plain bearings shall be the manufacturer's lot. Each designated thickness of laminated bearings used on a project shall constitute a lot. Unless otherwise specified on the plans or in the contract documents, sampling shall be at the rate of one bearing per lot. The supplier shall produce sufficient extra bearings pads to accommodate this sampling. Bearings pads from within a lot shall be selected at random by a representative of the Department as samples for inspection and testing.

714.11--Portland Cement Mortar, Grout and Concrete Patching Compounds.

714.11.1--General. The ingredients for portland cement mortar and grout shall conform to the following requirements:

Portland Cement	701.02
Masonry Cement	701.03
Water	714.01.2
Fine aggregate unless otherwise designated	703.02 or 703.18.
Calcium chloride	714.02
Hydrated lime	714.03.2
Fly Ash	714.05
Limestone Dust	714.03.5

714.11.2--Grout for Pressure Grouting. Grout for pressure grouting shall consist of a mixture of portland cement, water, calcium chloride, fly ash and/or limestone dust and fine sand in the proportions set forth in Section 412.

Fine sand shall meet the following requirements:

<u>Square Mesh Sieve</u>	<u>Percent Passing by Weight</u>
No. 10	100
No. 60	40 - 90
No. 200	0 - 50
Percent Silt	0 - 25
Percent Clay	0 - 12
Percent Organic Material	0 - 3
Plasticity Index	N.P.

714.11.3--Grout for Posttensioned Members. Grout for posttensioned members shall consist of a mixture of:

- 1 part portland cement, Type 1
- 1/4 part fly ash
- 3/4 part washed sand, all passing No. 16 sieve, not more than five percent retained on No. 30
- Four to six gallons of water per bag of cement

A plasticizing admixture, subject to approval by the Engineer, shall be used in accordance with the manufacturer's recommendations.

The grout shall be mixed in a mechanical mixer and shall be agitated until placed.

Members shall not be moved before the grout has set; ordinarily 24 hours minimum at 80°F or higher.

714.11.4--Blank.

714.11.5--Masonry Mortar. Masonry mortar shall consist of masonry cement mixed in accordance with the formula shown on the bag or shall consist of one part portland cement, three parts mortar sand, and sufficient water to make a mortar of such consistency that it can be easily handled and spread with a trowel. The addition of hydrated lime will be permitted in the proportion of 1/10 part by volume of the cement.

Mortar for use in other than masonry work, fine aggregate meeting the requirements of Subsection 703.02 may be used.

Unless an approved mortar mixing machine is used, the sand and mortar mix, or cement and lime, shall be mixed dry in a tight box until the mixture assumes a

uniform color, after which water shall be added as the mixing continues until the mortar attains the proper consistency.

Mortar shall be used within 45 minutes after its preparation. Retempering of mortar will not be permitted.

714.11.6--Rapid Setting Commercial Grouts and Concrete Patching Compounds. Rapid setting commercial grouts and concrete patching compounds must be approved for listing in the Department's "Approved Sources of Materials" prior to use, and shall be premeasured and packaged dry by the manufacturer. All liquid solutions included by the manufacturer as components of the packaged material shall be packaged in a watertight container. The manufacturer may include aggregates in the packaged material or recommend the addition of Contractor furnished aggregates.

The type, size and quantity of aggregates, if any, to be added at the job site shall be in accordance with the manufacturer's recommendations and shall meet the requirements of Subsection 703.02 for fine aggregate and Subsection 703.03 for coarse aggregate. Required mixing water to be added at the job site shall meet the requirements of Subsection 714.01.2.

Only those bonding agents, if any, recommended by the manufacturer of the grout or patching compounds may be used for increasing the bond to old concrete or mortar surfaces.

Grout or patching compounds containing chlorides will not be permitted when in contact with steel.

Site preparation, proportioning of materials, mixing, placing and curing shall be performed in accordance with the manufacturer's recommendation for the specific type of application, and the Contractor shall furnish a copy of these recommendations to the Engineer.

Rapid setting non-shrink commercial grouts and concrete patching compounds, including components to be added at the job site, shall conform to the following physical requirements:

Compressive strength shall equal or exceed 3000 psi in 24 hours when tested in accordance with Mississippi Test Method MT-4.

Bond strength shall equal or exceed 100 psi in 24 hours when tested in accordance with Mississippi Test Method MT-4.

The material shall not shrink, and the increase in length at 28 days shall not be greater than 0.3% when tested in accordance with Mississippi Test Method MT-4.

The Contractor shall furnish to the Engineer three copies of the manufacturer's certified test report(s) showing results of all required tests and certification that the material meets the specifications when mixed and placed in accordance with the manufacturer's instructions. When the mixture is to be placed in contact with steel, the certification shall further state that the packaged material contains no chlorides. Certified test report(s) and certification shall be furnished for each lot in a shipment.

The proportioning of materials must be approved by the State Materials Engineer and any subsequent change in proportioning must also be approved. A sample of each component shall be submitted to the Engineer along with the quantity or percentage of each to be blended. At least 45 days must be allowed for initial approval.

The proportioning of materials for subsequent lots may be approved by the State Materials Engineer upon receipt of certification from the manufacturer that the new lot of material is the same composition as that originally approved by the Department and that the material has not been changed or altered in any way.

714.11.7--Commercial Grout for Anchoring Doweled Tie Bars in Concrete.

714.11.7.1--Epoxy Grout Anchor System. Epoxy grout shall consist of one part liquid epoxy to a maximum of four parts clean dry silica sand by volume. The epoxy shall be a two-component epoxy-resin bonding system for application to portland cement concrete. The silica sand shall be bagged general purpose blast cleaning sand. The grout shall be placed with equipment that dispenses the grout evenly around the bar and completely fills the hole. Tamping the material in the hole by hand will not be satisfactory.

714.11.7.2--Non-Expanding Chemical Anchor System. Chemical anchor system shall consist of a premeasured unit containing polymeric or epoxy type resin, a hardener and may also include quartz sand aggregate. The resin and hardener shall be isolated from each other by a physical-chemical barrier or may be contained in separate premeasured units.

714.11.7.3--Installation. Unless otherwise specified, installation and hole sizes shall be in accordance with the manufacturer's recommendations.

714.11.7.4--Acceptance Procedure. The anchor system must be one from the Department's "Approved Sources of Materials". Prior to use, the Contractor shall furnish the Engineer three copies of the manufacturer's certification for each shipment stating that the material furnished is of the same composition as that originally approved by the Department and that the material has not been changed or altered in any way.

Each day an in-place tension test shall be performed at random on a tie bar with a

maximum curing time of two hours. If the test fails to meet the total load required to stress the bar to 50,000 psi, three additional tests shall be made at random. If any of the additional tests fail, all bars installed on that day shall be tested and any bar that fails shall be replaced. The Contractor shall furnish the testing device which shall include a certified calibration chart. No separate measurement for payment will be made for the testing device.

714.11.8--Epoxy Joint Repair System.

714.11.8.1--General. When the epoxy system is from the Department's current list of "Approved Sources of Materials", the Contractor shall furnish the Engineer three copies of the manufacturer's certification, for each shipment, stating that the epoxy and all components is the same composition as that originally approved by the Department and that the material has not been changed or altered in any way.

If the materials proposed for use are not from the Department's current list of approved materials, a sample of the epoxy and all components required for the epoxy mortar mix shall be submitted to the Engineer for evaluation and approval at least 30 calendar days prior to placement. Subsequent approval of each shipment may be by manufacturer's certification as set out above.

A representative of the epoxy manufacturer must be present for sufficient time to assure that the Contractor is properly schooled in the use of the epoxy materials.

714.11.8.2--Epoxy Resin. The material shall meet the requirements of ASTM Designation: C 881, Type I, Grade 2, Class C.

714.11.8.3--Silica Sand. The material shall be bagged general purpose blast cleaning sand.

714.11.8.4--Epoxy Mortar Mix. The mortar mix shall consist of one part liquid epoxy to 3.5 parts clean dry sand by volume.

714.11.8.5--Mixing and Curing. Mixing of all epoxy materials shall be accomplished with a mechanical mixer. A trial batch of mortar, approximately one cubic foot, will be mixed and used for joint repair. From this batch, the pot life and subsequent amount of material to be mixed will be determined.

714.12--Sprayed Finish for Concrete Surfaces. The spray material shall be an approved commercial product designed specifically for a sprayed finish and when applied to the concrete specimens at a rate of one gallon per 50 square feet shall conform to the following requirements:

714.12.1--Freeze-Thaw Test. Cast and cure three concrete specimens, not less than 4" x 6" x 6". Fourteen days moist curing with a drying period in room air at

60° to 80°F for 24 hours before coating with spray finish is required. Caution shall be taken that there be no excessive oil on specimen forms. Sides of specimens, brush permitted, shall be coated as herein set out and cured at room temperature for 48 hours; after which:

- (a) Immerse in water at room temperature, 60° to 80°F for three hours; remove and,
- (b) Place in cold storage at -15°F for one hour; remove and,
- (c) Thaw at room temperature, 60° to 80°F, for one hour.
- (d) Repeat (b) and (c) for 50 cycles.

At the end of the 50 cycle Freeze/Thaw Test, the specimens shall show no visible defects.

714.12.2--Accelerated Weathering. Material shall be subjected to a 5000 hour exposure test in accordance with ASTM Designation: G 151. Testing shall be performed in conjunction with either ASTM Designation: G 153, Carbon Arc Light Apparatus, or ASTM Designation: G 155, Xenon Arc Light Apparatus. Test Exposure Conditions shall be as specified in Table X1.1, Cycle 1 in ASTM Designation: G 153, or Table X3.1, Cycle 1 in ASTM Designation: G 155. At the end of the exposure test, the exposed sample must not show any chipping, flaking or peeling.

714.12.3--Fungus Growth Resistance. Material to be used shall pass a fungus resistance test as described by ASTM Designation: D 3273 with a minimum incubation period of 21 days where no growth shall have been indicated after the test.

714.12.4--Color. Unless otherwise specified or directed by the Bridge Engineer, the color of the finish shall be that deemed by the Engineer to be as close as practicable to the color of a rubbed concrete finish.

714.12.5--Testing and Certification. All testing shall be performed by a qualified commercial testing laboratory acceptable to the Engineer.

Before any part of a shipment is applied on the project, the Contractor shall furnish the Engineer with a certificate from the manufacturer attesting that the commercial product furnished conforms to the same formula as that previously subjected to the specified tests, and approved. Copies of the current test reports shall be attached to the certificate.

No test report for tests made more than four years prior to shipment to the project will be accepted.

714.13--Geotextiles.

714.13.1--General. Unless specified otherwise, the geotextile may be woven or non-woven. The fibers used in the manufacture of the geotextiles and the threads used in joining geotextiles by sewing, shall consist of long-chain synthetic polymers, composed of at least 95% by weight polyolefins, polyesters, or polyamides. They shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including selvages. The geotextile shall be mildew resistant and inert to biological degradation and naturally encountered chemicals, alkalines and acids. Geotextile which is not protected from sunlight after installation shall contain stabilizers and/or inhibitors to make it resistant to deterioration from direct sunlight, ultraviolet rays, and heat.

The edges of the geotextile shall be selvaged or finished in such a manner to prevent the outer yarn of filaments from raveling. The geotextile shall be free of defects or flaws, which affect the required physical properties.

Geotextile for silt fence shall be manufactured in widths of not less than three feet, and geotextile for other applications shall be manufactured in widths of not less than six feet. Sheets of geotextile may be sewn or bonded together at the factory or other approved locations, but deviation from the physical requirements will not be permitted.

Acceptance testing will be conducted with geotextile samples from each lot shipped to the project, as per Subsection 714.13.10.

714.13.2--Geotextile for Silt Fence. The geotextile shall conform to the physical requirements of Type I or II as shown in Table I. Unless a specific type is specified in the plans or contract documents, the Contractor may select Type I or II.

714.13.2.1--Woven Wire Backing. Except as provided herein, silt fence shall be reinforced with a woven wire backing. The wire backing shall be at least 32 inches high and have no less than six horizontal wires. Vertical wires shall be spaced no more than 12 inches apart. The top and bottom wire shall be 10-gauge or larger. All other wire shall be no smaller than 12½-gauge.

714.13.2.2--Posts. Wood or steel posts may be used. Wood posts shall have a minimum diameter of three inches and length of five feet and shall be straight enough to provide a fence without noticeable misalignment. Steel tee posts shall be five feet long, approximately 1 3/8" wide, 1 3/8" deep, and 1/8" thick with a nominal weight of 1.33 pounds per foot prior to fabrication. The posts shall have projections, notches or holes for fastening the wire backing or geotextile to the posts.

714.13.2.3--Staples. Staples shall be made of 9-gauge wire with a minimum length of one inch after bending.

714.13.3--Geotextile for Subsurface Drainage. Unless otherwise specified, the geotextile shall conform to the physical requirements of Type III as shown in Table I.

714.13.3.1--Geotextile for Edge Drains. The geotextile shall conform to the physical requirements of Type V as shown in Table I, except the AOS for the woven geotextile shall have a range of 0.15 mm to 0.43 mm.

714.13.4--Geotextile Underseal. The geotextile shall be non-woven polyester or polypropylene, which is satisfactory for use with asphalt cements. Unless otherwise specified, the geotextile shall conform to the physical requirements of Type IV in Table I.

714.13.5--Geotextile for Use Under Riprap. Unless otherwise specified, the geotextile shall conform to the physical requirements of Type V in Table I. The requirements for grab tensile, puncture, and trapezoidal tear strengths may be reduced 50 percent when the geotextile is cushioned from rock placement by a 6-inch minimum layer of sand.

714.13.6--Geotextile Stabilization. The geotextile shall meet the physical requirements as shown in Table I for the Type specified in the plans or contract documents.

714.13.7--Securing Pins. Steel pins used for anchoring the geotextile shall be three-sixteenth inch (3/16") in diameter, minimum length of 15 inches, pointed at one end and fabricated with a head for retaining a steel washer. A minimum one and one-half inch (1½") washer shall be installed on each pin.

714.13.8--Identification. Each roll of geotextile or container shall be visibly labeled with the name of the manufacturer, type of geotextile or trade name, lot number, and quantity of material.

714.13.9--Shipment and Storage. During shipment and storage, the geotextile shall be protected from direct sunlight, ultraviolet rays, temperatures greater than 140°F, mud, dirt, dust, and debris. The geotextile shall be wrapped and maintained in a heavy-duty protective covering, including ends of roll.

714.13.10--Certification, Acceptance Sampling and Testing. The Contractor shall furnish to the Engineer three copies of the manufacturer's certification that each lot in a shipment complies with the requirements of the contract. Certification of geotextile for silt fence shall include a material conformance statement, as per Subsection 700.05.1, that the geotextile meets or exceeds the minimum average roll values specified in Table 1. All geotextile, steel pins,

washers, fence posts, woven wire and wire staples are subject to approval by the Engineer upon delivery to the work site.

Acceptance testing shall be completed prior to incorporating in the work.

Acceptance of geotextile to be used in the work will be based on the results of tests performed by the Department on verification samples submitted from the project. The Engineer will select one roll at random, from each lot in a shipment, for sampling. A sample extending full width of the randomly selected roll and containing at least five square yards of geotextile will be obtained and submitted by the Engineer. The sample shall be provided at no additional cost to the State.

714.13.11--Table.

**TABLE I
GEOTEXTILES**

Type Designation	I ^a	II ^a	III	IV	V	VI		VII		
Application	Sediment Control		Drainage	Paving	Separation & Drainage	Separation, Stabilization & Reinforcement				
Physical Properties										Test Method
Grab Strength, Pounds	50	90	110	90	200	W 280	NW 180	W 450	NW 280	ASTM D 4632
Elongation %	----	50% max @ 45 lbs.	20% min	50% min @ break	50% min	50% max 50% min		50% max 50% min		ASTM D 4632
Seam Strength, Pounds	----	----	70	----	180	240	160	400	240	ASTM D 4632
Puncture Strength, Pounds	----	----	40	----	80	110	75	180	115	ASTM D 4883
Trapezoidal Tear, Pounds	----	----	40	----	80	100	70	150	100	ASTM D 4533
Asphalt Retention, gallons / square yard	----	----	----	0.2	----	----	----	----	----	ASTM D 6140
Permittivity, sec ⁻¹	0.05	0.05	0.5	----	0.15	0.2	0.2	0.2	0.2	ASTM D 4491
AOS Woven, mm	0.15 - 0.84	0.15 - 0.84	0.15 - 0.43	----	0.21 - 0.43	0.15 - 0.21	----	0.15 - 0.21	----	ASTM D 4751
AOS Non-Woven, mm	<0.84	<0.84	<0.43	----	<0.43	----	<0.43	----	<0.43	ASTM D 4751
Tensile Strength after UV, % Retained,	70@500Hr.	70@ 500 Hr.	70@ 150 Hr.	----	70@ 150 Hr.	70@ 150 Hr.		70@ 150 Hr.		ASTM D 4355
Melting Point, °F	----	----	----	325	----	----		----		ASTM D 276

a. All property values, with the exception of apparent opening size (AOS), represent minimum average roll values in the weakest principal direction. Values for AOS represent the maximum average roll values.

714.14--Geotextile for Moisture Barrier.

714.14.1--General. The geotextile for moisture barrier shall consist of sheeting, coated geotextile or a geotextile-sheeting laminate constructed exclusively of man-made materials. Sheeting shall be of single-layered construction. Coated geotextile shall be made of woven or non-woven polyester, polyetholene or polypropylene. The geotextile shall be furnished precoated on one or both sides or impregnated so as to make the geotextile impermeable to water or moisture. Geotextile-sheeting laminate shall consist of geotextile fused or heat-sealed to sheeting so as to form an integral geotextile membrane.

The geotextile shall be able to withstand normal handling and placement at material temperatures from 20°F to 145°F without endangering the serviceability of the material in the intended application. If the geotextile evidences de-lamination, such de-lamination may serve as grounds for rejection. The geotextile shall be mildew, abrasion, and puncture resistant and suitable for long term burial in the presence of water and/or moisture in the intended construction application. It shall be packaged in rolls of the length and width specified on the plans or directed by the Engineer.

714.14.2--Physical Requirements. The geotextile shall meet the following additional requirements when sampled and tested in accordance with the methods specified.

<u>Test</u>	<u>Requirements</u>	<u>Method</u>
Original Physical Properties		
Geotextile weight, ounces per square yard, air-dried tension-free sample.	Texas Test Method Tex-616-J"Testing Construction Fabrics"	6.5 minimum
Water permeability expressed as weight of water in ounces per square yard. Geotextile is subjected to the equivalent of a ten foot column of water for a period of two hours. Moisture passing through the geotextile is determined by weight gain of desiccant.	Tex-616-J	0.6 maximum
Abrasion Resistance expressed as weight of water in ounces per square yard. After prescribed sandblast the geotextile shall meet the requirement for water	Texas Test Method Tex-851-B "METHOD FOR EVALUATING THE ABRASION RESISTANCE OF PAVEMENT MARKING MATERIALS"	0.6 maximum

permeability.	modified as follows: six-inch sample distance, 40 psig regulated blast pressure and one kilogram of blast medium with a blast time of two minutes plus or minus 15 seconds per one kilogram of blast medium.	
Load characteristics at break or 100% elongation, whichever occurs first. Material shall meet specified minimum in both machine direction and cross- machine direction. Test values to be expressed in pounds.	ASTM Designation: D 5034, Grab Test G with 1-inch x2-inch jaws and constant time to break rate of extension of 20 plus or minus three seconds, as specified.	150 minimum
Apparent elongation at break or rupture, expressed in percent.	See Grab Test G above	20% minimum
Tear strength determined by the tongue, single rip, method on specimens prepared from "as-received" samples. Specimens are to be tested at a cross-head speed of twelve plus or minus 0.5 inches/minute. Test results are to be calculated by the "average of five highest peaks" method. Both the average of five specimens cut with the longer dimension parallel to the machine direction and the average of five specimens cut in the cross-machine direction shall meet the specified minimum expressed in pounds.	ASTM D 751	15 minimum

714.14.3--Packaging Requirements. The geotextile shall be packaged in rolls of the length and width specified on the plans or directed by the Engineer. The material shall be uniformly wound onto suitable cylindrical forms or cores to aid in handling and unrolling. Each roll shall be packaged individually in a suitable

sheath, wrapper or container to protect from ultraviolet light and moisture damage during normal storage and handling.

714.14.4--Identification. Each roll of geotextile or container shall be visibly labeled with the name of the manufacturer, type of geomembrane or trade name, date, lot number and length, width and quantity of material.

714.14.5--Sampling. A sample of five square yards of the geotextile shall be furnished to the State from each shipment for verification testing. The samples shall be provided at no cost to the State.

714.14.6--Certification. The Contractor shall furnish to the Engineer three copies of the manufacturer's certified test report(s) showing results of all required tests and certification that the material meets the specifications. Certification shall be furnished for each lot in a shipment.

714.15--Geogrids.

714.15.1--General. A geogrid is defined as a geosynthetic formed by a regular network of integrally connected elements with apertures greater than 0.25 inch to allow interlocking with surrounding soil, rock, earth and other surrounding materials to function primarily as reinforcement.

The geogrid shall be creep tested in accordance with ASTM Designation: D 5262. The long term design load that shall be reported for design use, shall be that load at which no more than 10% strain occurs over a 100-year design life of the geogrid, as calculated from tests run on representative samples for no less than 10,000 hours. The long term design load shall be reported unfactored, as the AASHTO strength reduction - Durability and Installation, and safety factors - will be considered by the MDOT Geotechnical Branch on a site specific design basis.

The geogrid shall meet the physical requirements of Table II for the type shown on the plans and shall be selected from the Department's list of "Approved Sources of Materials."

The geogrid shall be mildew resistant and inert to biological degradation and naturally encountered chemicals, alkalis and acids. The geogrid shall contain stabilizers and/or inhibitors, or a resistance finish or covering to make it resistant to deterioration from direct sunlight, ultraviolet rays, and heat.

714.15.2--Marking, Shipment and Storage. Each roll or container of geogrid shall be visibly labeled with the name of the manufacturer, trade name of the product, lot number, and quantity of material. In addition, each roll or container shall be clearly tagged to show the type designation that corresponds to that required by the plans. During shipment and storage the geogrid shall be

protected from direct sunlight, and temperatures above 120°F or below 0°F. The geogrid shall either be wrapped and maintained in a heavy duty protective covering or stored in a safe enclosed area to protect from damage during prolonged storage.

714.15.3--Manufacturer’s Certification. The Contractor shall furnish the Engineer three copies of the manufacturer’s certified test reports indicating that the geogrid furnished conforms to the requirements of the specifications and is of the same composition as that originally approved by the Department.

714.15.4--Acceptance Sampling and Testing. Final acceptance of each shipment will be based upon results of tests performed by the Department on verification samples submitted from the project, as compared to the manufacturer’s certified test reports. The Engineer will select one roll or container at random from each shipment for sampling. A sample extending full width of the randomly selected roll or container and being at least five (5) square yards in area will be obtained and submitted by the Engineer. The sample from each shipment shall be provided at no cost to the State.

**TABLE II
GEOGRIDS**

MINIMUM AVERAGE ROLL VALUE

Physical Properties	Type Designation						Test Method
	I	II	III	IV	V	VI	
Long Term Design Load, pounds per foot, Machine Direction	250	500	750	1500	2500	3500	ASTM Designation: D-5262
Minimum Ultimate Tensile Strength, pounds per foot, Machine Direction	500	1000	1500	3000	5000	7000	ASTM Designation: D-4595
Open Area, percent	70	70	50	50	50	50	Direct Measurement

SECTION 715 - ROADSIDE DEVELOPMENT MATERIALS**715.01--Topsoil.**

715.01.1--General. Topsoil shall be a well-graded soil of good uniform workable quality, free of debris, refuse, or foreign material and reasonably free of hard clods, gravel, concrete, sticks, or other undesirable material harmful to plant life.

715.01.2--Material to be Obtained from the Right-of-Way. Topsoil for slope treatment shall meet the general requirements as stated above and shall have a pH value of not less than 4.5 nor more than 8.0.

715.01.3--Material to be Furnished by the Contractor. Topsoil for slope treatment shall meet the general requirements of Subsection 715.01.1, shall have a pH value of not less than 4.5 nor more than 8.0, and shall be classified as a Group A-4 or A-6 soil with a minimum PI of 6.0 as specified by AASHTO Designation: M 145.

Topsoil for plant holes or pits shall be a rich, well-graded, well-drained soil of good uniform quality. The organic content, unless otherwise specified, shall not be less than three percent nor more than 20% as determined by ignition test on oven-dried samples. The pH value of the topsoil shall not be less than 4.5 nor more than 8.0. The Contractor may elect to mix or blend the materials for plant holes or pits so as to insure a homogenous mixture complying with the specific requirements of these specifications. No extra compensation will be allowed for the blending or mixing of materials.

715.01.4--Sampling and Testing. Sampling and testing of topsoil shall be as set out in Subsection 700.03.

715.02--Fertilizers.

715.02.1--General. Fertilizers shall comply with the fertilizer laws of the State of Mississippi.

715.02.2--Commercial, Combination or Manufactured, Fertilizer. Combination or manufactured fertilizer shall be "standard commercial products" and shall contain not less than the percentages by weight of the ingredients set out in Table A, except for agricultural limestone which shall meet the requirements of Subsection 715.02.2.1.

TABLE A
TYPES OF FERTILIZERS

	Combination												
	*10	18	6	15	12	8	0	13	Super Phosphate	Ammonium Nitrate	Urea	Muriate Potash	Ureaform
	10	46	8	10	24	24	20	13					
	10	0	8	10	12	24	20	13					
Chemical Components													
Nitrogen	*10	18	6	15	12	8	0	13		33	45		*38
Phosphorous P ₂ O ₅	10	46	8	10	24	24	20	13	20				
Potash K ₂ O	10	0	8	10	12	24	20	13				60	

- * Ureaform (38-0-0) -- This fertilizer shall contain a minimum of 38% total nitrogen, 27% of which shall be insoluble nitrogen derived from ureaform. The final mixture shall have a minimum activity index (AI) of 50% as determined by the appropriate AOAC procedure.
- * Ureaform (10-10-10) -- This fertilizer shall contain a minimum of 10% total nitrogen, 35% of which shall be insoluble nitrogen derived from ureaform. The final mixture shall have a minimum activity index (AI) of 40% as determined by appropriate AOAC procedure.

715-02.2.1--Agricultural Limestone. Agricultural limestone shall be either a Grade “A” liming material, or a marl or chalk agricultural liming material as addressed in the latest Mississippi Agricultural Liming Material Act of 1993, published by the Mississippi Department of Agriculture and Commerce.

715-02.2.1.1--Screening Requirements. Grade “A” liming material, including ground shells, shall not have less than 90% of the material passing the No. 10 sieve, and not less than 50% passing the No. 60 sieve. Marl or chalk liming material shall not have less than 90% of the material passing the No. 10 sieve.

715-02.2.1.2--Neutralizing Values. Grade “A” liming material shall not have less than 90% calcium and magnesium carbonate calculated as calcium carbonate equivalent when expressed on a dry weigh basis. Marl or chalk liming material shall not have less than 70% calcium and magnesium carbonate calculated as calcium carbonate equivalent when expressed on a dry weigh basis.

715.02.3--Sampling and Testing. Sampling and testing of agricultural limestone shall be in accordance with Subsection 700.03. Labels on containers or attached thereto showing the guaranteed analysis of other fertilizers will be prima facie evidence as to conformity with the specified requirements.

715.03--Seed.

715.03.1--General. All seeds shall comply with the seed law of the State of Mississippi and the current regulations duly promulgated thereunder. The seed shall be delivered in bags with certified tags or labels attached to each bag showing the seed name, kind, variety, percent of germination and purity of the seed, and the percent of obnoxious weeds and inert matter.

715.03.2--Germination and Purity Requirements. The requirements for germination and purity shall be as set out in Table B:

TABLE B
Germination and Purity Requirements

Name (Kind)	Name (Variety)	Percent Germination	Percent Purity
GRASSES			
Bermudagrass	Common	85	95
Bahiagrass	Pensacola or Wilmington	85	85
Tall Fescue	Kentucky 31	80	95
Lovegrass	Weeping	80	97
Carpetgrass	-----	80	85
Millet	Browntop	85	98
Oats	-----	90	98
Rye Grain	-----	80	98
Centipede	-----	80	85
LEGUMES			
Crimson Clover	Dixie, Chief, Tibbee, or Autauga	85	98
Annual Lespedeza	Kobe, Summit, or Climax	80	98
Sericea Lespedeza	Common, Interstate or Serala	80	98
Lespedeza	Vergata	90	98
Vetch	Hairy	85	95

715.03.3--Sampling and Testing. Except as provided in Subsection 214.02, the certified analysis shown on the seed bags will be used to determine the purity, obnoxious seeds, and inert matter as to conformance with the above requirements. Seeds from bags not identified by certified analysis or from bags with certified analysis indicating the seeds do not meet contract requirements shall not be used.

All seeds will be sampled and tested for percent germination, and the Department reserves the right to sample and test seeds for any required characteristic when deemed appropriate to do so as a check on the quality of the seeds; in which case the results of such tests shall be the basis for acceptance, rejection, or adjustment under the provisions of the contract.

Seeds to be tested by the Department will be sampled under the supervision of the District Materials Engineer. The seeds sampled by Department personnel will be sampled by means of a probe through the seed bags that are stored in accordance with Subsection 214.02.

The procedures for sampling, testing, acceptance, rejection, or adjustment will be in accordance with Subsection 214.02 supplemented by Department SOP.

715.03.4--Leguminous Inoculants. Approved legume seeds shall be treated with leguminous inoculant under the supervision of the Engineer. The inoculants for treating leguminous seeds shall be standard, pure culture of nitrogen fixing

bacteria. The seed shall be treated at the rate specified and according to the directions shown on the container of the inoculants and before the expiration date for use of the inoculant as also shown on the container.

715.04--Water. Water used in planting and establishment of vegetation shall comply with the applicable requirements of Subsection 714.01.

715.05--Vegetative Materials for Mulch. The vegetative materials for mulch shall be classed as follows:

Type I - Approved baled straw of wheat, oat, rye grain, or rice or broomsage or Bahia grass with seed heads which has reached maturity prior to cutting.

Type II - Approved baled hay produced from Bermuda, Bahia, Fescue, Dallis Grass, any of the Lespedezas, or combinations thereof.

All of the above materials shall have been properly cured prior to baling and shall be reasonably free from Johnson Grass and other noxious grasses and weeds. Vegetative material shall be reasonably bright in color, dry, and shall not be musty, moldy, or of otherwise low quality. Vegetative material that is wet or that has been baled green, not cured properly, shall not be used.

Unless otherwise permitted in writing by the Engineer, Type I shall be furnished and used. The Engineer may permit the use of Type II when the Contractor has furnished satisfactory evidence in writing that Type I material is not available.

715.06--Blank.

715.07--Mulch for Woody Plant Materials. The mulch materials shall conform to the following.

715.07.1--Tree Bark Mulch. The mulch shall be a standard manufactured product of ground, shredded, or broken particles from the bark of trees and shall be reasonably free of weed seeds, harmful bacteria, or disease spores and substances toxic to plant growth. The mulch particles shall be of the following type(s), as specified in the contract:

Type I - Commonly known as extra coarse. Particle size shall be approximately one inch to 2 1/2".

Type II - Commonly known as coarse. Particle size shall be approximately 1/2 inch to one inch.

Type III - Commonly known as medium. Particle size shall be approximately 1/4 inch to 1/2 inch.

Type IV - Commonly known as fine. Particle size shall be approximately 1/8 inch to 1/4 inch.

All tree bark mulch shall be handled so as to insure proper protection against contamination at all times. The mulch shall be delivered to the job in unbroken bags or bales with a manufacturer's label or tag on each container. Labels or tags on the containers shall show the physical analysis of the contents, the size of the particles, and the volume. Labels on containers or attached thereto showing the guaranteed analysis and volume will be prima facie evidence of the materials meeting the above requirements. All mulch will, however, be subject to approval by the Engineer as to quality and quantity.

715.07.2--Aggregate Mulch. Aggregate used as mulch shall be crushed or uncrushed gravel Size 5 or Size 56 meeting the gradation requirements of Subsection 703.14 for coarse aggregate cover material.

715.07.3--Straw. Straw material for mulch shall be classed as follows:

Class I - Approved baled wheat, oat, rice or rye straw. The materials shall have been cured properly prior to baling and shall be reasonably free from obnoxious grasses and weeds. The straw material shall be reasonably bright in color, dry and shall not be musty, moldy, or of otherwise low quality.

Class II - Approved baled pine needles that is reasonably free of twigs, branches, and obnoxious grasses and weeds. The material shall be dry and shall not be musty, moldy, or of otherwise low quality.

All straw mulch shall be inspected and approved by the Engineer prior to its use.

715.08--Fertilizer for Woody Plant Material. The fertilizer material for woody plants shall conform to the following requirements:

715.08.1--Fertilizer Packet. The fertilizer packet shall consist of an approved manufactured sealed polyethylene-paper laminated perforated packet containing one, two, or four ounces of water soluble fertilizer with a minimum guaranteed analysis of 16-8-16, 16% Nitrogen, 8% Phosphoric Acid, 16% Potash.

715.08.2--Fertilizer Tablet. The fertilizer tablet shall consist of an approved tightly compressed slow-release tablet 5, 10 or 21 gram size containing a minimum guaranteed analysis of 20-10-5, 20% Nitrogen, 10% Phosphoric Acid, 5% Potash.

715.08.3--Guaranteed Analysis. Labels on containers or attached thereto showing the guaranteed analysis will be prima facie evidence of the fertilizer materials meeting the specified requirements. All fertilizer packets and tablets will, however, be inspected and approved by the Engineer or, at the Engineer's

discretion, may be sampled and tested.

715.09 - Ditch Liner Material. All ditch liner materials shall be new and free of rips or tears.

715.09.1--Jute Mesh. Jute mesh shall be of uniform, plain weave with warp and weft yarns of approximately the same size. The physical requirements shall be:

Length	50 yards per roll, minimum
Width	48 inches, plus or minus one inch
Warp ends	78 per width, minimum
Weft yarns	41 per yard, minimum

The weight of cloth shall average 1.22 pounds per linear yard with a tolerance of plus 10% or minus 5%.

715.09.2--Excelsior Blanket. The excelsior blanket shall consist of a machine-produced mat of interlocking wood excelsior with uniform thickness and the fiber evenly distributed over the entire area of the blanket. A fabric net of extruded plastic shall be applied to one side of the excelsior wood mat to hold the wood fibers in place.

The blankets shall be supplied in a protective covering and shall not be exposed to moisture prior to placing. The blankets shall meet the following physical requirements.

Interlocking Wood Fibers	0.020" x 0.04" (±25%), 50% must be 3½ inches or longer
Fabric Net	1½" x 3½" maximum mesh size
Width	36-inch minimum

715.09.3--Erosion Control Blanket. The erosion control blanket shall consist of a machine-produced mat whose primary component is clean, weed-free straw from cereal grain crops. The straw must be evenly distributed throughout the mat. The top side of the blanket shall be covered with a photodegradable plastic mesh having 3/4" x 3/4" maximum openings which shall be substantially adhered to the straw by a knitting process using degradable thread. The blanket shall be supplied in a protective covering and shall meet the following requirements:

Straw *	0.50 pounds per square yards minimum dry weight
Netting	Photodegradable plastic
Width	48-inch minimum

* Coconut fiber may be used to replace a portion or all of the straw.

715.09.4--Erosion Control Fabric. The erosion control fabric shall consist of a flexible knitted construction of high strength degradable yarn with uniform openings interwoven with strips of biodegradable paper and shall conform to the following requirements:

- Width 48-inch minimum
- Weight 0.2 pounds per square yard, approximate

715.09.5--Wire Staples. The staples for securing the ditch liner material in place shall be a double prong "U" configuration made from 11-guage or heavier steel wire with an approximate length of six inches after bending.

715.09.6--Roving.

715.09.6.1--Polypropylene Roving. This material shall be formed from continuous strands of fibrillated polypropylene yarn, collected into a rove. Fibrillation is defined as a net-like physical structure of the yarn created by splitting the yarn in a precise pattern during manufacture.

The polypropylene shall contain a sufficient amount of UV inhibitors so as to retain 70 percent of its strength after 500 hours of exposure in an Atlas Twin Arc Weatherometer.

The fibrillated polypropylene roving shall have the following detailed requirements:

<u>Property</u>	<u>Limits</u>	<u>Test Method</u>
Strands / Rove	20-30	End Count
Yards per Pound of Rove	410-620	ASTM Designation: D 1907
Package Weight, pounds	18 minimum	Scale
Color	Black	

715.09.6.2--Fiberglass Roving. The material shall be formed from continuous fibers drawn from molten glass, coated with a chrome complex sizing compound, collected into strands, and lightly bound together into a rove.

The fiberglass roving material shall meet the following detailed requirements:

<u>Property</u>	<u>Limits</u>	<u>Test Method</u>
Yield, yards per pound	170 - 300	ASTM Designation: D 578
Fiber Diameter, inch	0.00035 - 0.00055	ASTM Designation: D 578
Strands / Rove	50 - 70	End Count
Package Weight, pounds	25-50	Scale

715.09.7--Certification. The Contractor shall furnish the Engineer with three copies of the manufacturer's certification for each shipment of ditch liner material stating the amount furnished and that the material complies with the requirements of the specifications and also forward three copies of the manufacturer's or distributor's certification showing the wire size for each shipment of staples.

The certifications by the manufacturer or distributor will be prima-facie evidence of the materials meeting the specified requirements. All ditch liner material and staples will, however, be subject to approval by the Engineer.

SECTION 716 - MISCELLANEOUS METALS

716.01--General. All miscellaneous metals shall be as shown on the plans or in the special provisions, and shall conform to the requirements as hereinafter set out, unless otherwise specified.

Unless waived by the Engineer, the Contractor shall furnish the State Materials Engineer three copies of certified test reports from an approved testing laboratory covering all material described in this section.

716.02--Steel Castings.

716.02.1--Carbon Steel Castings. Carbon steel castings shall conform to AASHTO Designation: M 103. Grade 70-36 shall be furnished unless otherwise specified.

716.02.2--Chromium Alloy-Steel Castings. Chromium alloy-steel castings shall conform to ASTM Designation: A 743. Grade CA-15 shall be furnished unless otherwise specified.

716.03--Steel Forgings. Steel forgings shall conform to AASHTO Designation: M 102. Class C forgings shall be furnished unless otherwise specified.

716.04--Gray Iron Castings. Gray iron castings shall conform to AASHTO Designation: M 105. Class 30B shall be furnished unless otherwise specified. For testing purposes a lot size shall be defined as the lesser of either a total of 35,000 pounds or one week's production for the Department. The test bar shall be made from a melt of iron used in production of units for the Department. The

test bar length shall be a minimum of 16 inches.

716.05--Malleable Castings. Malleable castings shall conform to ASTM Designation: A 47. Grade No. 35018 shall be furnished unless otherwise specified.

716.06--Bronze Castings and Bearings. Bronze castings and bearings shall conform to AASHTO Designation: M 107. Alloy UNS No. C91100 shall be furnished unless otherwise shown on the plans.

716.07--Copper Bearings and Sheet Copper.

716.07.1--Rolled Copper-Alloy Bearings and Expansion Plates. Rolled copper-alloy bearings and expansion plates shall conform to ASTM Designation: B 100. Alloy UNS No. C51000 shall be furnished unless otherwise specified.

716.07.2--Sheet Copper. Sheet copper shall meet the requirements of AASHTO Designation: M 138 including the embrittlement test. The Copper No. shall be as designated on the plans.

716.08--Self-Lubricating Bearing Plates. Self-lubricating bearing plates shall be an article of standard production by an established manufacturer of such equipment. They shall be provided with trepanned or drilled recesses, not grooves, which shall be filled with a lubricating compound capable of withstanding the atmospheric elements and consisting of graphite and metallic substances with a lubricating binder. This compound shall be pressed into the recesses by hydraulic presses so as to form dense nonplastic lubricating inserts. The lubricating area shall comprise not less than 25% nor more than 35% of the total bearing area. Contractor shall furnish additional lubricating material in stick form. Just prior to erecting the members which rest on the bronze plates, the Contractor shall thoroughly rub the steel bearing plates which rest on the bronze with the lubricant. These surfaces shall be unpainted and shall be cleaned with a steel brush immediately before the lubricant is applied.

The bearing plates shall be made of (1) rolled bronze conforming to the requirements of Subsection 716.07.1, or (2) cast bronze conforming to requirements of Subsection 716.06, Alloy UNS No. C91100 or No. C90500, except that a maximum lead content of 2.5% is allowable.

The coefficient of friction shall not exceed 0.10 when subjected to design loading and also when subjected to twice the design loading.

Contact surfaces shall be finished in the direction of motion in accordance with the requirements of ANSI B46 1-55 No. 125. All machined surfaces shall be flat within 0.0005 inch per inch of length and width. In mating curved surfaces of steel and bronze, the concave surfaces may have a plus tolerance of 0.01 inch and

the convex surfaces, a minus tolerance of 0.01 inch.

The Contractor shall furnish the manufacturer's shop drawings showing pattern and size of recesses.

716.09--Babbitt. Babbitt shall conform to ASTM Designation: B 23. The alloy number shall be as designated on the plans.

716.10--Lead Plates, Pipes, Etc. Lead used for plates, pipes, etc. shall conform to ASTM Designation: B 29, Grade: Pure Lead.

716.11--Galvanized Pipe. Galvanized pipe for water, gas, etc. shall conform to ASTM Designation: A 53.

716.12--Rolled Zinc. Rolled zinc shall conform to ASTM Designation: B 69. The type shall be as designated on the plans.

716.13--Blank.

716.14--Bar Grates.

716.14.1--Material Requirements. Plain round steel bars and strap bars shall conform to the following requirements:

B-9 Grates and Bar Grates	AASHTO Designation: M 270, Grade 36
MI, GI, & SS-3 Grates	AASHTO Designation: M270, Grade 50W, or ASTM Designation: A 588, Grade 50W

716.14.2--Fabrication and Finish. All bar grates shall be constructed in accordance with these specifications and in conformity with the detailed plans.

Holes shall be punched or drilled in the strap bars to accommodate the round bars. The junctions of all round bars and/or strap bars shall be welded. The completed bar grate shall exhibit good workmanship.

After fabrication, the bar grate shall be coated with an approved commercial quality coating designed for coating steel castings and fabricated units. The State Materials Engineer shall approve the coating material prior to application.

SECTION 717 - STRUCTURAL STEEL

717.01--Structural Steel.

717.01.1--General. Steel shall be furnished according to the following

specifications. Unless otherwise specified, structural carbon steel shall be furnished. Steels other than those required herein may be specified on the plans. When steel is used in welded construction, the welding procedure shall be suitable for the steel and the intended service.

717.01.2--Requirements for Structural Steel. Structural steel shall meet the applicable ASTM Standards which shall include the Supplementary Bend Test Requirement and the following Charpy V-Notch Requirements for minimum service temperature 0°F and above:

ASTM DESIGNATION	THICKNESS & FABRICATION	MINIMUM CHARPY V-NOTCH ENERGY @ TEMPERATURE
A 36	Up to 4"	15 ft. lb. @ 70°F
*A 588	Up to 4" Mechanically Fastened	15 ft. lb. @ 70°F
*A 588	Up to 2" Welded	15 ft. lb. @ 70°F
*A 588	Over 2" to 4" Welded	20 ft. lb. @ 70°F
*A 572	Up to 4" Mechanically Fastened	15 ft. lb. @ 70°F
*A 572	Up to 2" Welded	15 ft. lb. @ 70°F
*A 572	Over 2" to 4" Welded	20 ft. lb. @ 70°F
A 514	Up to 4" Mechanically Fastened	25 ft. lb. @ 30°F
A 514	Up to 2½" Welded	25 ft. lb. @ 30°F
A 514	Over 2½" to 4" Welded	35 ft. lb. @ 30°F
A 852	Up to 4" Mechanically Fastened	20 ft. lb. @ 50°F
A 852	Up to 2½" Welded	20 ft. lb. @ 50°F
A 852	Over 2½" to 4" Welded	25 ft. lb. @ 50°F

* If the yield strength of the material exceeds 65 ksi, the temperature for the CVN value for acceptability will be reduced 15°F for each increment or fraction thereof of 10 ksi above 65 ksi.

The procedure for sampling and testing shall be in accordance with ASTM Designation: A 673. The (H) Frequency of Heat Testing shall be used for all the steel specifications except ASTM Designation: A 514 which shall be in accordance with the (P) Frequency of Piece Testing.

If ASTM Designation: A 517 steel is used in lieu of A 514, the sampling and testing requirements shall be the same as the A 514 of equal thickness.

717.01.3--Structural Carbon Steel. Structural carbon steel for bolted and welded construction shall be in accordance with ASTM Designation: A 36.

717.01.4--Eyebars. Steel for eyebars shall be a weldable grade. These grades include structural steel conforming to:

- (a) Structural Carbon Steel ASTM Designation: A 36.

- (b) High-Strength Low-Alloy Structural Steel with 50,000 psi, minimum yield point to four inches (4") thick, ASTM Designation: A 588 with supplementary requirements for Charpy V-Notch mandatory.

717.01.5--High Strength Low-Alloy Structural Steel. High-Strength Low-Alloy Structural Steel shall conform to:

- (a) High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality, ASTM Designation: A 572.
- (b) High-Strength Low-Alloy Structural Steel with 50,000 psi, minimum yield point to four inches (4") thick, ASTM Designation: A 588.

717.01.6--High Strength Low-Alloy Structural Steel for Welding. High-Strength Low-Alloy Structural Steel for welding shall conform to:

- (a) High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality, ASTM Designation: A 572, Grade 50.
- (b) High-Strength Low-Alloy Structural Steel with 50,000 psi, minimum yield point to four inches (4") thick, ASTM Designation: A 588.

717.01.7--High-Strength Structural Steel for Bolted Construction. High-Strength Structural Steel for bolted construction shall conform to:

- (a) High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality, ASTM Designation: A 572, Grade 50.
- (b) High-Strength Low-Alloy Structural Steel with 50,000 psi, minimum yield point to four inches (4") thick, ASTM Designation: A 588.

717.01.8--High-Yield-Strength, Quenched, and Tempered Alloy Steel Plate. High-Yield-Strength, Quenched and Tempered Alloy Steel Plate shall conform to:

- (a) High-Yield-Strength, Quenched, and Tempered Alloy Steel Plate, suitable for welding, ASTM Designation: A 514.
- (b) High-Strength Alloy Steel Plates, Quenched and Tempered for pressure vessels, ASTM Designation: A 517.

717.01.9--Acceptance Procedure. Structural Steel shall be accepted on the basis of manufacturer's certified test reports. The Contractor shall furnish the Engineer with three copies of the certified test reports.

717.02--Fasteners. Fasteners for structural steel joints shall conform to the ASTM specifications with revisions, as specified herein.

717.02.1-- Plain Finish Fasteners.

717.02.1.1--Bolts. Ungalvanized bolts shall meet the requirements of ASTM Designation: A 325 or ASTM Designation: A 490, as specified on the plans.

717.02.1.2--Heavy Hex Nuts. Ungalvanized nuts shall meet the requirements of ASTM Designation: A 194, Grade 2H, or A 563, Grade DH, as specified on the plans.

717.02.1.3--Hardened Washers. Ungalvanized washers shall meet the requirements of ASTM Designation: F 436.

717.02.2--Galvanized Fasteners.

717.02.2.1--Galvanized Bolts. Bolts shall meet the requirements of ASTM Designation: A 325, Type 1. Galvanizing shall be in accordance with ASTM Designation: A 153, Class C, or ASTM Designation : B 695, Class 50. Thickness of zinc coating shall be measured on the wrench flats or top of bolt head.

717.02.2.2--Galvanized Nuts. Nuts shall meet the requirements of ASTM Designation: A 563, Grade DH. Galvanizing shall be in accordance with ASTM Designation: A 153, Class C, or ASTM Designation: B 695, Class 50. Thickness of zinc coating shall be measured on the wrench flats.

717.02.2.3--Galvanized Washers. Washers shall meet the requirements of ASTM Designation: F 436. Galvanizing shall be in accordance with ASTM Designation: A 153, Class C, or ASTM Designation: B 695, Class 50.

717.02.2.4--Direct Tension Indicators. Direct tension indicators shall meet the requirements of ASTM Designation: F 959 and galvanized in accordance with ASTM Designation: B 695, Class 50.

717.02.3--Revisions to ASTM Specifications.

717.02.3.1--ASTM Designation: A 325. Hardness for bolt diameters 1/2-inch to 1-inch inclusive shall have a minimum Rockwell C Hardness Number of 24 and a maximum Rockwell C Hardness Number of 33.

717.02.3.2--ASTM Designation: A 563. Nuts that are to be galvanized shall be tapped oversize the minimum amount required for proper assembly. The amount of overlap in the nut shall be such that the nut will assemble freely on the bolt in the coated condition and shall meet the rotational-capacity test set out in Subsection 717.02.3.4.

The overlapping requirements of ASTM Designation: A 563, Subsection 7.4, shall be considered maximum values instead of minimum, as currently shown.

Galvanized nuts shall be lubricated with a lubricant containing a dye of any color that contrasts with the color of the galvanizing.

717.02.3.3--ASTM Designation: F 606.

717.02.3.3.1--Bolts. Proof load tests shall be performed in accordance with Method 1, Length Measurement. Minimum frequency of tests shall be as specified in ASTM Designation: A 325 for "Production Lot Method."

Wedge tests on full size bolts are required. If bolts are to be galvanized, the tests shall be performed after galvanizing. Minimum frequency of tests shall be as specified in ASTM Designation: A 325, "Production Lot Method."

717.02.3.3.2--Nuts. Proof load tests shall be performed in accordance with ASTM: F 606, Subsection 4.2. If nuts are to be galvanized, tests shall be performed after galvanizing, overtapping and lubricating.

717.02.3.3.3--Washers. If galvanized washers are supplied, hardness testing shall be performed after galvanizing. The coating shall be removed prior to taking hardness measurements.

717.02.3.4--Rotational-Capacity Testing of Assemblies. Rotational-capacity tests are required and shall be performed on all black or galvanized bolt, nut and washer assemblies by the manufacturer or distributor prior to shipping. Tests on galvanized bolts and hardware shall be performed after galvanizing. Washers are required as part of the test even though they may not be required as part of the installation procedure. Except as modified herein, the rotational-capacity test shall be performed in accordance with the requirements of ASTM Designation: A 325.

The following shall apply:

- (a) Each combination of bolt production lot, nut lot and washer lot shall be tested as an assembly. Where washers are not required by the installation procedures, they need not be included in the lot identification.
- (b) A rotational-capacity lot number shall be assigned to each combination of lots tested.
- (c) The minimum frequency of testing shall be two assemblies per rotational-capacity lot.
- (d) The bolt, nut and washer assembly shall be assembled in a Skidmore-Wilhelm Calibrator or an acceptable equivalent device. For short bolts which are too short to be assembled in the Skidmore-Wilhelm Calibrator

see (h) below.

- (e) The minimum rotation, from a snug tight condition (10% of the specified proof load), shall be:

240°, 2/3 turn, for bolt lengths < 4 diameters
360°, 1 turn, for bolt lengths ≥ 4 diameters and < 8 diameters
480°, 1 1/3 turn, for bolt lengths ≥ 8 diameters

- (f) The tension reached at the above rotation shall be 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, inches	1/2	5/8	3/4	7/8	1	1 1/2	1 1/4	1 3/8	1 1/8
Required Installation Tension, kips	12	19	28	39	51	56	71	85	103
Turn Test Tension, kips	14	22	32	45	59	64	82	98	118

- (g) After the required installation tension listed above has been exceeded, one reading of tension and torque shall be taken and recorded. The torque value shall conform to the following:

Torque ≤ 0.25 PD

Where:

Torque = measured torque, foot-pounds
P = measured bolt tension, pounds
D = bolt diameter, feet

- (h) Bolts that are too short to test in Skidmore-Wilhelm Calibrator may be tested in a steel joint. The tension requirement of (f) above need not apply. The maximum torque requirement of (g) above shall be computed using a value of P equal to the turn test tension shown in the table in (f) above.

717.02.4--Reporting. The results of all tests, including zinc coating thickness, required herein and in the appropriate ASTM specifications shall be recorded on the appropriate document. Location where tests are performed and date of tests shall be reported on the appropriate document. The manufacturer or distributor that performs the test shall certify that the results recorded are accurate. The manufacturer shall certify that the steel and the assembly components are domestic products.

717.02.5--Documentation.

717.02.5.1--Mill Test Report(s) (MTR). MTR shall be furnished for all mill steel used in the manufacture of the bolts, nuts, and washers. MTR shall indicate

the place where the material was melted and manufactured.

717.02.5.2--Manufacturer Certified Test Report(s) (MCTR). The manufacturer of the bolts, nuts, and washers shall furnish the Department three copies of test reports (MCTR) for the items furnished. Each MCTR shall have the appropriate MTR attached. Each MCTR shall contain the information required in Subsection 717.02.4.

The manufacturer performing the rotational-capacity test shall include on the MCTR the following:

- (a) The lot number of each of the items tested.
- (b) The rotational-capacity lot number as required in paragraph (b) of Subsection 717.02.3.4.
- (c) The results of the tests required in Subsection 717.02.3.4.
- (d) The pertinent information required in Subsection 717.02.4.
- (e) A statement that MCTR for the items are in conformance to this specification and the appropriate ASTM specifications.
- (f) The location where the bolt assembly components were manufactured.

717.02.5.3--Distributor Certified Test Report(s) (DCTR). The following shall be applicable for DCTR:

- (a) The DCTR shall include MCTR above for the various bolt assembly components.
- (b) The rotational-capacity test may be performed by a distributor in lieu of a manufacturer and reported on the DCTR.
- (c) The DCTR shall show the results of the tests required in Subsection 717.02.3.4.
- (d) The DCTR shall also show the pertinent information required in Subsection 717.02.4.
- (e) The DCTR shall show the rotational-capacity lot number as required in paragraph (b) of Subsection 717.02.3.4.
- (f) The DCTR shall certify that the MCTR are in conformance to this specification and the appropriate ASTM specifications.

717.02.6--Shipping. Bolts, nuts and washers, where required, from each rotational-capacity lot shall be shipped in the same container. If there is only one production lot number for each size of nut and washer, the nuts and washers may be shipped in separate containers. Each container shall be permanently marked with the rotational-capacity lot number such that identification will be possible at any stage prior to installation.

Three copies of the appropriate MTR, MCTR or DCTR shall be furnished to the Department.

717.02.7--Final Acceptance. Final acceptance of high strength bolts, nuts, washers and direct tension indicators will be based on tests performed on samples obtained from the project by the Department. Tests will be performed in accordance with the procedures set out in these specifications. A lot shall be defined as each shipment to a project from the manufacturer's lot number and of the same size and length. The integrity of each lot shall be maintained until tests are completed by the Department.

Each lot of bolts, shall be sampled as follows:

<u>Lot Size</u>	<u>Sample Size</u>
150 or less	2
151 to 280	4
281 to 500	6
501 to 1,200	10
1,201 to 3,200	16
3,201 to 10,000	26
10,001 and over	40

Note: One-half of the sampled bolts will be used for tensile testing and the other one-half will be tested for coating and/or hardness.

Each lot of nuts or washers shall be sampled as follows:

<u>Lot Size</u>	<u>Sample Size</u>
800 or less	1
801 to 8,000	2
8,001 to 22,000	3
22,001 and over	5

Note: The sample size shall be doubled when galvanized nuts or washers are specified or used.

Each lot of direct tension indicators shall be sampled as follows:

<u>Lot Size</u>	<u>Sample Size</u>
35,000 or less	16
35,001 to 250,000	26
250,001 and over	32

Direct tension indicators shall be tested in accordance with ASTM Designation: F 959. One-half of the samples will be tested in compression and the remaining one-half will be tested for coating.

717.03--Copper Bearing Steels. When copper bearing steel is specified, the steel shall contain not less than 0.2 percent copper.

717.04--Welded Stud Shear Connectors.

- (a) Shear connector studs shall conform to the requirements of Cold Finished Carbon Steel Bars and Shafting, ASTM Designation: A 108, Cold-Drawn Bars, Grades 1015, 1018, or 1020, either semi or fully killed. If flux retaining caps are used, the steel for the caps shall be of a low carbon grade suitable for welding and shall comply with Cold-Rolled Carbon Steel Strip, ASTM Designation: A 109.
- (b) Tensile properties as determined by tests of bar stock after drawing or of finished studs shall conform to the following requirements:

Tensile Strength, minimum	60,000
Yield Strength*, minimum	50,000
Elongation, minimum	20% in 2 inches
Reduction of area, minimum	50%

* As determined by a 0.2 percent offset method.

- (c) Tensile properties shall be determined in accordance with the applicable sections of ASTM Designation: A 370, Mechanical Testing of Steel Products. Tensile tests of finished studs shall be made on studs welded to test plates. If fracture occurs outside of the middle half of the gage length, the test shall be repeated.
- (d) Finished studs shall be uniform quality and condition, free from injurious laps, fins, seams, cracks, twists, bends, or other injurious defects. Finish shall be as produced by cold drawing, cold rolling, or machining.
- (e) The manufacturer shall certify that the studs as delivered are in accordance with the material requirements of this section. Certified copies of in-plant quality control test reports shall be furnished to the Engineer upon request.

- (f) The Engineer may select, at the Contractor's expense, studs of each type and size used under the contract, as necessary for checking the requirements of this section.

717.05--Steel Grid Flooring.

717.05.1--Steel. All steel shall conform to the Specification for Structural Steel of the ASTM Designation: A 36, ASTM Designation: A 572, Grade 50, or ASTM Designation: A 588. Unless the material is galvanized, it shall have a copper content of 0.2 percent.

717.06--Pins and Rollers. Steel for pins and rollers shall conform to the designations listed in Tables I and II below.

Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws. Pins and rollers more than nine inches in diameter shall be forged rollers and annealed. Pins and rollers nine inches or less in diameter may be either forged and annealed or cold-finished carbon-steel shafting.

In pins larger than nine inches in diameter, a hole not less than two inches in diameter shall be bored full length along the axis after the forging has been allowed to cool to a temperature below the critical range, under suitable conditions to prevent injury by too rapid cooling, and before being annealed.

Table I

Minimum Material Properties Structural Steel				
Type	Structural Carbon Steel	High Strength Low-Alloy Steel		High Yield Strength Quenched and Tempered Alloy and Low Alloy Steel
Designation ASTM	A 36	A 572, Grade 50	A 588	A 514/A 517
Thickness of Plates	Up to and including 8 inches	Up to and including 4 inches	Up to and including 4 inches	Over 2½ inches up to and including 4 inches
Minimum Tensile Strength, Fu	58,000	65,000	70,000	100,000
Minimum Yield Point or Minimum Yield Strength, Fy	36,000	50,000	50,000	90,000

Table II

Minimum Material Properties Pins and Rollers				
Expansion rollers shall be not less than 4 inches in diameter				
ASTM Designation	A 108	A 668	A 668	A 668 *
Grade or Class	Grades 1016 to 1030 inclusive	Class D	Class F	Class G
Size Limitations	4 inches or less in diameter	Up to 20 inches in diameter	Up to 10 inches in diameter	Up to 20 inches in diameter
Minimum Yield, Point, psi, Fy	36,000	37,500	50,000	50,000

* May substitute rolled material of the same properties.

SECTION 718 - TIMBER AND DIMENSION LUMBER

718.01--Timber and Dimension Lumber. General. All timber and dimension lumber shall be Southern pine and shall conform in all respects to applicable requirements of AASHTO Designation: M 168. Inspection for conformance to these specifications will be conducted in accordance with Department SOP.

Timber and dimension lumber shall be furnished in the sizes shown on the plans or as specified. Unless otherwise specified, timber and dimension lumber shall be No. 1, or better, graded according to the latest American Lumber Standards.

Only one type of preservative shall be used for the treatment of materials for any one class of construction on a project, unless otherwise specified.

718.02--Untreated Timber and Dimension Lumber. Untreated timber and dimension lumber shall comply with the requirements set out in Subsection 718.01.

718.03--Treated Timber and Dimension Lumber. Timber and dimension lumber to be treated shall meet the requirements herein specified and shall be treated by a pressure method to the minimum required retainage of preservative as specified on the plans or elsewhere in the specifications. Treated timber or dimensional lumber will not be accepted for use unless it has been inspected by an authorized representative of the Department and found to be satisfactory both before and after treatment. Inspection prior to treatment may be waived by the Testing Engineer when the preservative will be pentachlorophenol or chromated copper arsenate.

718.03.1--Seasoning. Seasoning timber, dimension lumber, piles and poles to be treated with preservatives shall conform to the requirements of AWP.

718.03.2--Treatment.

718.03.2.1--General. Insofar as practicable, each charge shall consist of pieces approximately equal in size, moisture, and sapwood content into which approximately equal quantities of preservative can be injected. Each layer of material shall be separated at each end, and at the center when necessary, by strips at least 3/8 inch in thickness; caps, stringers, and other large timbers shall be separated by strips of at least 1/2-inch thickness.

All timber and lumber shall be treated in accordance with AWP treating practices unless otherwise specified herein.

Unless otherwise directed, the type and minimum quantity of preservative shall be in accordance with TABLES 1, 2 or 3.

Any treated timber or lumber to be painted shall be treated in accordance with

Subsection 718.04.3, Type B solvent, or Subsection 718.04.4.

Brackish water, as listed in TABLES 1, 2 or 3, shall mean salt waters, bordering land, and waters adjacent thereto which are subject to tidal flow.

718.03.2.2--Penetration. Unless otherwise specified, treated timber and lumber shall show a 100 percent sapwood penetration or a minimum penetration of four inches.

The test method for determining the amount of preservative retained will be either as specified in AWP or Mississippi Test Methods. The borer cores shall be obtained in accordance with AWP Standard M2 and shall be taken from pieces having a sapwood depth at least equal to the sampling zone specified as follows:

- (a) Round Units, piling and poles, shall be in accordance with AWP requirements.
- (b) Structural members less than four inches shall be from zero to one and one half inches from the surface.
- (c) All other structural members shall be from zero to two inches from the surface.

718.03.2.3--Inspection. The Department shall be notified sufficiently in advance of treating the material so that an inspector may be furnished at the plant to inspect the material and the treatment of same. All materials and processes used in the manufacture of the material shall be subject to inspection. The plant shall be equipped with the necessary gauges, thermometers, appliances, and facilities to enable the inspector to determine the conditions at all stages of the treatment and to satisfy the inspector that the requirements of the specifications are fulfilled. The manufacturer shall also provide the apparatus and chemicals necessary for making tests at the plant as required by the Department. All equipment, apparatus, etc., shall be maintained in proper and satisfactory condition for use at all times.

Tests for penetration of preservative shall be made with an increment borer. Test holes shall be plugged with treated plugs. All borings shall be taken at the center of the narrow side of the piece. Sufficient borings shall be taken to insure that the specified penetration has been obtained, with a minimum of 20 borings required for each charge of materials.

If 20% or more of the borings from a charge of treated material fail to meet the penetration requirements, the entire charge shall be rejected and subject to retreatment. If upon retreatment, the material meets the penetration requirements, it will be accepted. Only one retreatment will be permitted, and

any apparent damage due to retreatment shall be cause for rejection.

718.03.3--Handling Treated Material. Any bruising or rough handling will be cause for rejection.

718.03.4--Storage of Treated Material. All material treated for stock shall be stacked as compactly as possible on a well-drained surface. Material shall be supported on sills spaced as necessary, not to exceed 10 foot intervals and shall have at least one foot of air space beneath the stacks.

All materials treated with CCA for use in buildings and applications where painting is required shall be dried after treatment. The treated wood shall be kiln dried by American Lumber Standards, or air dried for a period of at least 21 days before shipment.

718.04--Preservative. The preservatives shall meet the applicable requirements of AWWA, and the water content in an oil preservative shall not exceed 3.0% unless otherwise approved by the Engineer; but in no case shall it exceed 5.0%.

718.04.1--Creosote Oil. The creosote oil shall meet the requirements of AWWA P-1. The test methods shall be either AWWA or Mississippi Test Methods.

718.04.2--Creosote-Coal Tar Solution. The creosote coal tar solution shall meet the requirements of AWWA P-2. The test methods shall be either AWWA or Mississippi Test Methods.

718.04.3--Pentachlorophenol. The pentachlorophenol shall meet the requirements of AWWA P-8. The test methods shall be either AWWA or Mississippi Test Methods.

The hydrocarbon solvent used in the pentachlorophenol solution shall meet the requirements of AWWA P-9, Type A or B. When painting is required, Type B solvent shall be used. Type A solvent shall be used for all other treatment unless otherwise specified.

718.04.4--Chromated Copper Arsenate (CCA). The solution shall contain a sufficient concentration of the water-born preservative to produce the minimum specified retention. The preservative shall meet the requirements of AWWA P-5, CCA Type B or C. The test methods shall be either AWWA or Mississippi Test Methods.

TABLE 1
Minimum Treatment Rates For Creosote,
and Creosote-Coal Tar Preservatives

Material	Coastal Area and Brackish Water		Other Locations	
	Retention pounds / cubic foot	Preservative Required	Retention pounds / cubic foot	Preservative Required
Lumber (1)	20	(3)	12	(2) or (3)
Piling	20	(3)	12	(2) or (3)
Poles	9	(2) or (3)	9	(2) or (3)

- Notes: (1) Lumber in the Coastal Area which will not be in contact with brackish water may be treated as specified for "Other Locations".
(2) Creosote conforming to Subsection 718.04.1.
(3) Creosote-Coal Tar conforming to Subsection 718.04.2.

TABLE 2
Minimum Treatment Rates For Pentachlorophenol Preservative
conforming to Subsection 718.04.3

Material	Coastal Areas and Brackish Water	Other Locations
	Retention pounds / cubic foot	Retention pounds / cubic foot
Lumber	(1)	0.80
Piling	Penta Not Permitted	0.80
Poles	0.60	0.60
Material to be Painted	(2)	(2)

- Notes: (1) Pentachlorophenol not permitted for lumber which will be in contact with brackish water. Lumber in the Coastal Area which is not in contact with brackish water may be treated as specified for "Other Locations".
(2) Treated at the rate specified above using AWWA P-9, Type B Solvent.

TABLE 3
Minimum Treatment Rate For Chromated Copper Arsenate Preservative
conforming to Subsection 718.04.4

Material	Coastal Areas and Brackish Water	Other Locations
	Retention pounds / cubic foot	Retention pounds / cubic foot
Lumber (1)	2.50	0.80
Piling	2.50	0.80
Poles	0.60	0.60

Notes: (1) Lumber in the Coastal Area which is not in contact with brackish water may be treated as specified for "Other Locations".

SECTION 719 - PILES

719.01--General. Piles shall be untreated timber, treated timber, precast concrete, cast-in-place concrete, or steel piles, as specified and in addition to the general requirements of these specifications and the plans, shall conform to the specific requirements hereinafter set forth, unless otherwise stipulated.

719.02--Timber Piles. All piles shall conform to the requirements of ASTM Designation: D 25, except as hereinafter specified. Inspection for conformance to these specifications will be conducted in accordance with Department SOP.

The circumference and diameters of piling shall be in conformity with Table I.

719.02.1--Untreated Timber Piles. Untreated timber piles may be any species which will satisfactorily withstand driving. They shall be reasonably clean-peeled.

719.02.2--Treated Timber Piles. Treated timber piles shall be Southern Pine preferably cut during the winter season. Treated timber piles shall be inspected and treated in accordance with the requirements set forth in Section 718.

TABLE I
CIRCUMFERENCES AND DIAMETERS OF TIMBER PILES

Length	Three Feet From Butt				At Tip	
	Minimum		Maximum		Minimum	
	Circum- ference	Approx. Diameter	Circum- ference	Approx. Diameter	Circum- ference	Approx. Diameter
Feet	inches	inches	inches	inches	inches	inches
Under 40	38	12	63	20	25	8
40 to 50*	38	12	63	20	22	7
51 to 70*	41	13	63	20	22	7
70 to 90*	41	13	63	20	19	6
Over 90	44	14	63	20	19	6
* inclusive						

719.03--Concrete Piles. Concrete piles, both prestressed and cast-in-place, shall be constructed in conformity with the plans and in accordance with these specifications. Additional requirements for prestressed piles are set out in Section 803.

All concrete materials and their preparation and placing shall be in accordance with the requirements of the class of concrete specified and in accordance with Section 803.

Reinforcing steel shall conform to the requirements of Section 711.

719.04--Steel Piles. The material in rolled steel piles shall be standard structural grade steel of the section number, size, and weight per linear foot indicated on the plans. The steel shall conform to the requirements of ASTM Designation: A 36.

The Contractor shall furnish the State Materials Engineer three certified copies of the mill test reports containing the true chemical and physical analyses of the material.

719.05--Steel Sheet Piling. Steel sheet piling shall conform to the requirements of ASTM Designation: A 328.

The Contractor shall furnish the State Materials Engineer with three certified copies of the mill test reports containing the true chemical and physical analyses of the material.

SECTION 720 - PAVEMENT MARKING MATERIALS

720.01--Glass Beads. The beads shall be transparent, clean, colorless glass, smooth and spherically shaped, free from milkiness, pits, or excessive air bubbles and conform to the specific requirements for the class designated. Unless otherwise specified, Class A glass beads shall be furnished.

720.01.1--Class A. The Class A, Standard, beads shall be Type 1, non-flotation with a moisture resistant coating conforming to the requirements of AASHTO Designation: M 247.

720.01.2--Class B. The Class B, High-Visibility, beads shall be non-flotation, embedment coated and conform to the following specific requirements.

720.01.2.1--Gradation. The beads shall meet the gradation requirements of Table 1.

Table 1

U.S. Standard <u>Sieve No.</u>	<u>% Retained</u>
12	0
14	0-5
16	5-20
18	40-80
20	10-40
25	0-5
Pan	0-2

720.01.2.2--Roundness. The beads shall have a minimum of 80 percent rounds per screen for the two (2) highest sieve quantities. The remaining sieve fractions shall be no less than 75 percent rounds.

720.01.2.3--Angular Particles. The beads shall have no more than three (3) percent angular particles per screen.

720.01.2.4--Refractive Index. The beads shall have a refractive index of 1.50 to 1.52.

720.01.3--Packaging and Marking. The beads shall be packaged in 50 or 55-pound moisture proofed bags. Each bag shall be stamped with the following information: name and address of manufacturer, shipping point, trademark or name, the wording "glass beads", class, weight, lot number and the month and year of manufacture.

720.01.4--Acceptance Procedures. The manufacturer shall furnish the MDOT Central Laboratory three copies of the certified test report(s) showing results of

all required tests and certification that the material meets the specifications. Acceptance sampling and testing of glass beads will be in accordance with MDOT S.O.P. No. TMD-40-02-00-000.

720.02--Thermoplastic Pavement Markings. The thermoplastic material shall conform to AASHTO Designation: M 249 except the glass beads shall be moisture resistant coated.

The manufacturer/producers of the thermoplastic compound, glass beads, epoxy resin, and primer/sealer shall furnish to the Engineer three copies of certified test reports showing results of all tests specified therein and shall further certify that the materials meet all requirements.

720.03--Raised Pavement Markers.

720.03.1--General. Raised pavement markers, including high performance raised pavement markers, shall be listed on the Department's "Approved Sources of Materials".

720.03.2--Type of Markers. Pavement and jiggle markers shall conform to one or more of the following types:

- Type A Non-Reflective White Jiggle Markers
 - Class 1 Acrylonitrile-Butadiene-Styrene Polymer Markers
 - Class 2 Ceramic Markers
- Type AY Non-Reflective Yellow Jiggle Markers
 - Class 1 Acrylonitrile-Butadiene-Styrene Polymer Markers
 - Class 2 Ceramic Markers
- Type B 2-Way Clear Reflective Markers
- Type C Red-Clear Reflective Markers
- Type D 2-Way Yellow Reflective Markers
- Type E One-Way Clear Reflective Markers
- Type F One-Way Yellow Reflective Markers
- Type G Yellow-Clear Reflective Markers
- Type H Chip Seal Clear Reflective Markers
- Type I Chip Seal Yellow Reflective Markers

High performance raised pavement markers shall be available in Types B through G.

720.03.3--Acceptance Procedures.

720.03.3.1--Marker Type A. The Contractor shall furnish the Engineer three copies of the manufacturer's certified test reports covering all pavement markers shipped to the project. The certified test report shall show the test results on each part of each section contained in Mississippi Test Method MT-17 and shall state

that the markers represented by the test results comply with the specifications contained herein in all respects.

The pavement markers will be tentatively accepted on the basis of the manufacturer's certified test reports. Final acceptance shall be based on check samples as set out in Subsection 720.03.4.

720.03.3.2--Marker Type B through G. The Contractor shall furnish the Engineer three copies of the manufacturer's certification covering all pavement markers shipped to the project. The certification shall state that the raised pavement markers meet the applicable requirements of ASTM Designation: D 4280.

The pavement markers will be tentatively accepted on the basis of the manufacturer's certification. The Department reserves the right to obtain check samples as deemed necessary for determining compliance with this specification.

720.03.3.3--Marker Type H and I. Prior to use, the Contractor shall furnish the Engineer three copies of a certification for each shipment stating that the material furnished is of the same composition as that originally approved by the Department and that the material has not been changed or altered in any way. The Department will obtain check samples as deemed necessary for determining compliance with this specification.

720.03.4--Sampling, Tolerances, and Packaging. Pavement markers shall conform to sampling, tolerance, and packaging requirements as set out below.

720.03.4.1--Sampling. For Marker Type A, H and I, ten (10) markers of each type and class, selected at random, will constitute a representative sample for each lot regardless of lot size.

For Marker Type B through G, check sampling, when performed, shall require ten (10) markers of each type, selected at random, to constitute a representative sample for each lot regardless of lot size.

A resample of any marker type will consist of twice as many markers as originally sampled.

720.03.4.2--Tolerances.

720.03.4.2.1--Tolerances For Marker Type A, H & I. At least 90% of the original sampling of each lot of markers shall pass all tests with the following exceptions:

When less than 90% but more than 70% pass all tests, a resample of that lot will be allowed at the request of the Contractor. When less than 70% of the markers from the original sample comply with the requirements, the lot

represented by the samples will be rejected and no resample will be allowed. Tolerances for resamples shall be in the same ratio as specified above.

At least two of three specimens, randomly selected for strength, water absorption, and autoclave, and also the averages of the three, must pass the stated requirements; otherwise, three additional markers selected at random shall be tested, and if the same conditions for passing are not met for these latter three markers, the lot will be rejected.

720.03.4.2.2--Tolerances For Marker Type B through G. At least 90% of the check sampling of each lot of markers shall pass the strength test required in the Physical Properties Section of ASTM Designation: D 4280 with the following exceptions:

When less than 90% but more than 70% pass the test, a resample of that lot will be allowed at the request of the Contractor. When less than 70% of the markers from the check sample comply with the requirements, the lot represented by the samples will be rejected and no resample will be allowed. Tolerances for resamples shall be in the same ratio as specified above.

720.03.4.3--Packaging. Shipments shall be made in containers which are acceptable to common carriers and packaged in such a manner as to insure delivery in perfect condition. All damaged shipments shall be replaced by the Contractor.

Each package shall be clearly marked as to the name of the manufacturer, type, quantity enclosed, lot number, and date of manufacture.

720.03.5--Non-Reflective Pavement Markers. Non-reflective jiggle markers shall be either Class 1 or Class 2. Markers shall be approved products as listed on the Department's "Approved Sources of Materials" for jiggle bar markers.

720.03.5.1--Class 1 Markers. Class 1 non-reflective jiggle markers shall consist of an acrylonitrile-butadiene-styrene polymer or other approved material, and shall be 4 inches wide x 6 inches long. Infrared curves of materials used in markers shall match approved curves on file at the Central Laboratory.

Class 1 markers shall conform to the following requirements when tested in accordance with Mississippi Test Method: MT-17.

<u>Property</u>	<u>Requirement</u>
Heat Resistance	No change in shape or appearance
Impact Resistance	No break, chip or crack
Load Resistance	No break, chip, crack or permanent deformation

720.03.5.2--Class 2 Markers. Class 2 non-reflective jiggle markers shall consist

of a heat-fired, vitreous, ceramic base, and a heat-fired, opaque, glazed surface to produce the properties required in these specifications. The bottom of the marker shall not be glazed. The markers shall be produced from any suitable combination of intimately mixed clays, shales, talcs, flints, feldspars, or other inorganic material which will meet the properties herein required. The markers shall be thoroughly and evenly matured and free from defects which affect appearance or serviceability.

Non-reflective markers shall conform to the following finish and testing requirements:

The top surface of the marker shall be in reasonably close conformity with the configuration shown on the plans. All edges shall be rounded and any change in curvature shall be gradual. The top and sides shall be smooth and free of mold marks, pits, indentations, air bubbles, or other objectionable marks or discolorations. The base of all markers shall be flat. The deviation from a flat surface shall not exceed 0.05 inch and shall be free from gloss glaze or substances that may reduce its bond to the adhesive.

All tests shall be performed in accordance with Mississippi Test Method: MT-17, which will be on file in the Materials Division.

<u>Test</u>	<u>Requirement</u>
Glaze thickness	0.005 inch minimum
Moh Hardness	6 minimum
Directional reflectance, Type A, white markers only	
Glazed Surface	75 minimum
Body of Marker	70 minimum
Yellowness Index, Type A, white markers only	
Glazed Surface	0.07 maximum
Body of Marker	0.12 maximum
Color, Type AY, yellow markers only,	
FHWA Highway Yellow Color Tolerance Chart	PR Color # 1
Autoclave	Glaze shall not spall, craze, or peel
Compressive Loading	750 pounds, minimum
Water Absorption	2.0% maximum

720.03.6--Reflective Pavement Markers. Reflective pavement markers shall be listed on the Department's "Approved Sources of Materials" and shall meet the

applicable requirements of ASTM Designation: D 4280.

720.03.7--Adhesive for Pavement Markers.

720.03.7.1--General Requirements. The adhesive shall be an asphaltic or thermoplastic material suitable for bonding pavement markers to portland cement concrete pavement, hot bituminous pavement and chip-sealed surfaces when the road surface and marker temperatures are in the range of 50°F to 160°F. The composition of the adhesive must 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.

720.03.7.2--Specific Requirements. In addition to the specific requirements set forth herein, the adhesive shall be listed on the Department's "Approved Sources of Materials" prior to its use.

720.03.7.3--Packaging and Labeling. The adhesive shall be packaged in self-releasing cardboard containers which will stack properly. The label shall show the manufacturer, quantity, and lot or batch number. "Adhesive for Pavement Markers" or "Adhesive for Traffic Markers" shall be printed in bold lettering on the label.

720.03.7.4--Sampling. A minimum of 10 pounds of adhesive per lot or batch received shall be submitted to the State Materials Engineer for compliance testing. This may be submitted in the form of an adhesive testing package from each batch or material obtained from a package shipped to the project.

720.03.7.5--Manufacturer's Certified Test Report. The adhesive will be tentatively accepted by a manufacturer's certified test report. The certified test report shall show the test results and shall state that the adhesive represented by the test results meets all the requirements of the contract and has the properties and characteristics as herein specified. It shall be the Contractor's responsibility to furnish three copies of the manufacturer's test report for each batch of adhesive shipped to the project.

720.03.7.6--Bituminous Adhesive, Standard Type. The asphaltic material and mineral filler shall comply with the following requirements:

(a) Adhesive Properties:

	<u>Minimum</u>	<u>Maximum</u>	<u>Test Method</u>
Softening Point, °F	200	-	ASTM: D 36
Penetration @ 77°F	10	20	ASTM: D 5
Flow, inch	-	0.2	MT-73
Heat Stability Flow, inch	-	0.2	MT-73
Viscosity, 400°F, Poises	-	75	MT-73
Flash Point, C.O.C., °F	550	-	ASTM: D 92

(b) Asphalt properties determined on the filler-free material derived from the extraction and Abson recovery process as explained in Mississippi Test Method MT-73.

	<u>Minimum</u>	<u>Maximum</u>	<u>Test Method</u>
Penetration, 100 g, 5 sec, 77°F	25	-	ASTM: D 5
Viscosity, 275°F, Poises	12	-	ASTM: D 2171
Viscosity Ratio, 275°F	-	2.2	MT-73

(c) Filler properties determined using the filler separation technique described in Mississippi Test Method MT-73.

	<u>Minimum</u>	<u>Maximum</u>	<u>Test Method</u>
Filler Content, percent by weight	50	75	MT-73
Filler Fineness, percent passing:			
Sieve No. 100	100	-	MT-73
Sieve No. 200	90	-	MT-73
Sieve No. 325	75	-	MT-73

720.03.7.7--Flexible Adhesive. The hot applied flexible pavement marker adhesive shall be a hot melt thermoplastic material capable of bonding the marker without excessive marker movement at hot summer temperatures and remain flexible at winter temperatures. The adhesive shall comply with the following physical requirements when melted in accordance with ASTM Designation: D 3407 and poured into suitable test molds:

<u>Test</u>	<u>Result</u>	<u>Test Method</u>
Penetration, 77°F	25 max.	ASTM Designation: D 5
Softening point	200°F min.	ASTM Designation: D 36
Brookfield viscosity, 400°F	10,000 cp max.	ASTM Designation: D 3236
Ductility @ 77°F, 5 cm/min	15 cm min.	ASTM Designation: D 113
Ductility @ 39.2°F, 1 cm/min	5 cm min.	ASTM Designation: D 113
Asphalt Compatibility	Pass	ASTM Designation: D 5329
Flexibility	Pass at 20°F	Per Subsection 720.03.7.8

720.03.7.8--Test Procedure for Flexibility.

Sample Preparation - One-eighth inch thick steel shims are used to enclose an opening which is one-inch wide and four-inches long on a sheet of release paper or a release treated metal plate. The heated adhesive is poured into the opening until it is slightly overfilled. After one hour of cooling the excess adhesive is trimmed flush with the shims using a hot knife and then the sample is removed from the shims.

Conditioning - The trimmed samples are placed in a freezer maintained at 20 ±2°F for a minimum of four hours.

Testing - The conditioned samples are removed from the freezer and immediately bent over a one-inch diameter mandrel through an arc of 90 degrees in 10 seconds at a uniform rate of nine degrees per second. A passing result is one in which no cracking occurs in the test sample. At least two of the three specimens tested must meet the flexibility requirement at 20°F for a passing result.

720.04--Cold Plastic Pavement Markings.

720.04.1--General. The prefabricated markings described shall consist of white or yellow pigmented plastic films with reflective glass spheres uniformly distributed throughout their entire cross-sectional area, and be capable of being affixed to bituminous or portland cement concrete pavements by either a pressure sensitive precoated adhesive or a liquid contact cement. The markings shall be provided complete in a form that will facilitate rapid application and protect the markings in shipment and storage. The manufacturer shall identify proper solvents and/or adhesives to be applied at the time of application, all equipment necessary for proper application, and recommendations for application that will assure an effective performance life.

Prefabricated legends and symbols shall conform to the applicable shapes and sizes as outlined in the current "Manual on Uniform Traffic Control Devices."

Cold plastic pavement markings shall be listed on the Department's "Approved Sources of Materials". Prior to use, the Contractor shall furnish the Engineer three copies of the manufacturer's certification for each shipment stating that the material furnished is of the same composition as that originally approved by the Department and that the material has not been changed or altered in any way.

720.04.2--Requirements. Unless otherwise indicated on the plans, the material shall be 60 mil retroreflective pliant polymer film.

720.04.2.1--Composition. The retroreflective pliant polymer pavement marking film shall consist of a mixture of high quality polymeric materials, pigments, 1.5 index glass beads uniformly distributed throughout its cross sectional area and with a reflective layer of beads bonded to the top surface. The film shall be composed of the following materials:

<u>Material</u>	<u>Minimum Percent by Weight</u>
Resins & Plasticizers	20
Pigments	30
Graded Glass Beads	33

This film shall be capable of being fabricated into pavement markings of specified thickness and dimensions and of being adhered to asphaltic and/or portland cement concrete by means of a pressure sensitive precoated adhesive, or a liquid contact cement which is applied at the time of installation.

720.04.2.2--Conformability and Resealing. The retroreflective pliant polymer pavement marking film shall be capable of conforming 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 film of the same composition under normal conditions of use.

The film shall show patchability when tested as follows:

- (a) Cut two 1-inch x 3-inch pieces of the pliant polymer and mark the reflective side of one of the pieces with a pencil to delineate a 1-inch x 1-inch area at the end of the piece.
- (b) Wet the surface of the area delineated with a cloth soaked in contact cement or a mixture of MEK and toluene for one minute, keeping the surface wet. At the end of one minute, scrape the beads and binder off the sample and wipe the residual binder from the area. Let the sample dry for at least one minute.
- (c) Remove the liner from the back of the second piece of film and place the backside on top of the cleaned area on the first piece. The sample, while held together, should now form one piece four inches long by one inch wide with the 1-inch x 1-inch overlap patch in the center.
- (d) Place the patched sample on a hard surface under 1,000 grams per square inch, the area of the overlap splice, maintained at 140°F for two hours.
- (e) Remove the sample from the heat and allow to cool to 70°F, room temperature.
- (f) Pull the sample in opposite directions to place a shear strain on the patched area. The two pieces shall not separate without tearing.

720.04.2.3--Tensile Strength. The film shall have a minimum tensile strength of 40 pounds per square inch of cross section when tested according to ASTM Designation: D 638. A 6-inch x 1-inch x 0.06-inch sample shall be tested at a

temperature between 70°F and 80°F using a jaw speed of 12 inches per minute.

720.04.2.4--Elongation. The film shall have a minimum elongation of 75% at break when tested according to ASTM Designation: D 638 using a jaw speed of 12 inches per minute.

720.04.2.5--Plastic Pull Test. A test specimen made the same size as in Subsection 720.04.2.3 shall support a dead weight of four pounds for not less than five minutes at a temperature between 70°F and 80°F.

720.04.2.6--Pigmentation. The pigments shall be selected and blended to provide a marking film which is white or yellow conforming to standard highway colors through the expected life of the film.

720.04.2.7--Glass Beads. The glass beads shall be colorless and have a minimum index of refraction of 1.50 when tested using the liquid oil immersion method. The size and quality of the beads will be such that performance requirements for the retroreflective pliant polymer film shall be met.

Bead adhesion shall be such that beads are not easily removed when film surface is scratched firmly with thumbnail.

The film shall have glass bead retention qualities such that when a 2-inch x 6-inch sample is bent over a 1/2-inch diameter mandrel, with the 2-inch dimension perpendicular to the mandrel axis, microscopic examination of the area on the mandrel shall show no more than 10% of the beads with entrapment by the binder of less than 40%.

720.04.2.8--Skid Resistance. The surface of the retroreflective pliant polymer film shall provide a minimum skid resistance value of 35 BPN when tested according to ASTM Designation: E 303.

720.04.2.9--Reflective Intensity. The photometric quantity to be measured shall be specific luminance and shall be expressed as millicandelas per square foot per foot candle. The minimum initial reflective values shall be 250 for white and 200 for yellow as measured in accordance with Mississippi Test Method MT-70.

720.04.2.10--Reflectivity Retention. The following tests shall be employed to measure reflectivity retention:

- (a) **Taber Abraser Simulation Test.** Using a taber abraser with an H-18 wheel and a 125-gram load, the sample shall be inspected at 200 cycles, under a microscope, to observe the extent and type of bead failure.

No more than 15% of the beads shall be lost due to pop-out and the predominant mode of failure shall be "wear down" of the beads.

(b) Qualitative Tests. Bead bond strengths shall be judged under a microscope with a magnification of at least 5X. The beads shall be difficult to remove, and when removed, beads shall show a portion of the polymeric bead bond retained with the beads rather than clean removal from the sockets.

720.04.2.11--Thickness. Unless otherwise indicated on the plans, the retroreflective pliant polymer film, without adhesive, shall be supplied in a standard thickness of 0.06 inch.

720.04.2.12--Effective Performance Life. The film, when applied according to the recommendations of the manufacturer, shall provide a neat, durable marking that will not flow or distort due to temperature if the pavement surface remains stable. Although reflectivity is reduced by wear, the pliant polymer shall provide a cushioned, resilient substrate that reduces bead crushing and loss. The film shall be weather resistant and, through normal traffic wear, shall show no appreciable fading, lifting or shrinkage throughout the useful life of the marking, and shall show no significant tearing, roll back, or other signs of poor adhesion.

720.04.3--Manufacturer's Certification. The Contractor shall furnish the Engineer three copies of the manufacturer's certification stating that each lot in a shipment complies with the requirements of the contract.

720.04.4--Acceptance Sampling and Testing. Final acceptance of each lot will be based on results of tests performed by the Department on verification samples submitted from each lot shipped to the project. The Engineer will select one sample at random from each lot in the shipment for testing. A sample extending full width of the randomly selected sample and five linear feet in length will be obtained and submitted by the Engineer. The sample from each shipment shall be provided at no cost to the State.

720.05--Preformed Pavement Markings for Construction Zones.

720.05.1--General. In addition to the specific material requirements set forth herein, pavement marking materials must have been approved for listing in the Department's "Approved Sources of Materials" prior to their use.

The preformed markings shall consist of retroreflective materials on a conformable backing. The pigments shall be selected and blended to provide pavement markings which conform to standard highway colors.

The size, quality, and refractive index of the glass beads shall be such that the performance requirements for the markings will be met. The bead adhesion shall be such that beads are not easily removed when the material surface is scratched with a thumbnail.

The markings shall be precoated with a pressure sensitive adhesive capable of adhering to asphalt and portland cement concrete pavement in accordance with the manufacturer's instructions without the use of heat, solvents or other additional adhesives. The markings and/or adhesive shall not require any curing time after application.

The markings shall be provided in specified widths and shapes. Preformed words and symbols shall conform to the applicable shapes and sizes as outlined in the current "Manual on Uniform Traffic Control Devices for Streets and Highways," or as modified.

The materials shall be packaged in accordance with accepted commercial standards and when stored indoors in a cool dry place, shall be suitable for use one year after date of purchase.

720.05.2--Classification of Markings. Retroreflective preformed pavement markings shall be of the following types, as specified on the plans or in the contract documents:

720.05.2.1--Type 1. The markings shall consist of a mixture of high quality polymeric materials, pigments and glass beads with a reflective layer of beads bonded to the top surface. A non-metallic medium coated with a pressure sensitive adhesive shall be incorporated to facilitate removal. The adhesive shall be of a type that is completely removed with the pavement marking or colorless so as not to leave a color mark on the pavement.

Reflectance. The markings shall meet or exceed the initial reflectance values when measured in accordance with the testing procedures of ASTM Designation: D 4592.

INITIAL REFLECTANCE VALUES

	<u>White</u> 86°		<u>Yellow</u> 86°	
Entrance Angle	0.2°	0.5°	0.2°	0.5°
Observation Angles	1770	1270	1310	820
SL (mcd/ft ² /fc)				

The photometric quantity to be measured shall be specific luminance (SL) and shall be expressed in millicandelas per square foot per footcandle. The test distance shall be 50 feet, and the sample size shall be a 2.0 x 2.5-foot rectangle. The angular aperture of both the photoreceptor and light projector shall be six minutes of arc. The reference center shall be the geometric center of the sample, and the reference axis shall be taken perpendicular to the test sample.

The quantity SL (specific luminance) treats the retroreflector as a surface source rather than a point source whose projected area is visible as an area at the

observation position. The quantity SL related to the way the effective retroreflective surface is focused on the retina of the human eye and to the visual effect thereby produced. It is recommended for describing the performance of highway signs and striping, or large vehicular markings which are commonly viewed as discernable surface areas.

720.05.2.2--Type 2. The pavement markings shall consist of retroreflective materials on a conformable metallic backing, precoated with a pressure sensitive adhesive which is colorless so as not to leave a color mark on the pavement or of a type that is substantially removed with the pavement marking.

Reflectance. The markings shall meet or exceed the initial reflectance values when measured in accordance with the testing procedures of ASTM Designation: D 4592.

INITIAL REFLECTANCE VALUES

	<u>White</u> 86°		<u>Yellow</u> 86°	
Entrance Angle				
Observation Angles	0.2°	0.5°	0.2°	0.5°
SL (mcd/ft ² /fc)	1360	760	820	510

The sample size, test procedure and measurement of test values shall be as prescribed for Type 1 in 720.05.2.1.

720.05.3--Certificates of Compliance. The Contractor shall furnish the Engineer three copies of certifications from the manufacturer for each lot of pavement markings stating that the material meets the requirements of the contract.

720.06--Preformed Permanent Foil Tape. Preformed foil tape shall be one from the Department's "Approved Sources of Materials". Prior to use, the Contractor shall furnish the Engineer three copies of a certification for each shipment stating that the material is of the same composition as that originally approved by the Department and that the material has not been changed or altered in any way.

720.07--High Performance Cold Plastic Pavement Markings.

720.07.1--General. The preformed high performance pavement markings shall consist of white or yellow films with ceramic beads incorporated to provide immediate and continuing retroreflection.

Preformed high performance cold plastic pavement markings shall be listed on the Department's list of "Approved Sources of Materials" for Preformed High Performance Profile Cold Plastic Pavement Marking Tape. Prior to use, the

Contractor shall furnish the Engineer three copies of the manufacturer's certification for each shipment stating that the material furnished is of the same composition as that originally approved by the Department and that the material has not been changed or altered in any way.

The preformed pavement markings shall be capable of being adhered to the pavement by a pre-coated pressure sensitive adhesive. A primer may be used to precondition the pavement surface. When a primer is specified by the manufacturer, it shall be installed as recommended by the manufacturer at no additional cost to the State. The preformed pavement markings shall conform to pavement contours by the action of traffic. After application, the markings shall be immediately ready for traffic. A representative of the manufacturer shall be present to identify proper solvents and/or primers, where necessary, to be applied at the time of application, to identify all equipment necessary for proper application, and to make recommendations for application that will assure effective product performance.

720.07.2--Classification. The preformed pavement markings shall be highly durable retroreflective pliant polymer materials designed for longitudinal markings subjected to high traffic volumes.

720.07.3--Requirements.

720.07.3.1--Composition. The retroreflective pliant polymer pavement marking film 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 ceramic beads bonded to a durable polyurethane top surface. The surface shall have approximately 50 ±15% of the surface area raised and presenting a near vertical face angle of 0° to 60° to traffic from any direction. The channels between the raised areas shall be substantially free of exposed beads or particles.

720.07.3.2--Retroreflectance. The white and yellow markings shall have the following initial minimum retroreflectance values as measured in accordance with the testing procedures of ASTM Designation: D 4061. The photometric quantity to be measured shall be coefficient of retroreflected luminance (R_L), and shall be expressed as millicandelas per square foot per foot-candle ($\text{mcd}/\text{ft}^2/\text{fc}$).

INITIAL MINIMUM RETROREFLECTANCE VALUES

	White		Yellow	
Entrance Angle	86.0°	86.5°*	86.0°	86.5°*
Observation Angle	0.2°	1.0°	0.2°	1.0°
Retroreflected Luminance, R_L ($\text{mcd}/\text{ft}^2/\text{fc}$)	1100	700	800	500

* These retroreflectance values are based on dark room photometric readings

per ASTM D 4061. The Ecolux™ Retroreflectometer measurement geometry is an 86.5° entrance angle and a 1.0° observation angle.

720.07.3.3--Glass Beads. The size and quality of the beads shall be such that the performance requirements for the retroreflective pliant polymer shall be met.

720.07.3.3.1--Index of Refraction. All ceramic beads bonded to the polyurethane coated patterned surface of the material shall have a minimum index of refraction of 1.70 when tested using the liquid oil immersion method. The glass beads mixed into the pliant polymer shall have a minimum index of refraction of 1.5 when tested by the liquid oil immersion method.

TESTING PROCEDURE FOR REFRACTIVE INDEX OF BEADS BY LIQUID IMMERSION

EQUIPMENT REQUIRED:

- A. Microscope, minimum 100X magnification
- B. Light Source - preferably sodium light or other monochromatic source, but not absolutely essential
- C. Refractive Index Liquids*
- D. Microscope Slide and Slide Cover
- E. Mortar and Pestle

* Available from R.P. Cargille Laboratories, Inc., Cedar Grove, NJ

PROCEDURE:

- A. Using the mortar and pestle, crush a few representative beads and place a few of these crushed particles on a microscope slide.
- B. Place a drop of a refractive index liquid, with an index as close to that of the glass as can be estimated, on the crushed bead particles.
- C. Cover the slide with a microscope slide cover and view the crushed particles by transmitted light normal to the slide surface by illumination from the bottom.
- D. Adjust the microscope mirror to allow a minimum light intensity for viewing. This is important when sodium light is not used.
- E. Bring a relatively flat and transparent particle into focus.
- F. By slightly raising and lowering the microscope tube, look for one or both of the following:
 - 1. Becke Line - This light line will appear to move either into the particle or away from it. In general, when the microscope tube is raised, the line will move toward the material of higher refractive index; when the microscope tube is lowered, the line will move toward the material of lower index.
 - 2. Variation in Particle Brightness - When raising the microscope tube from sharp focus, the particle will appear to get brighter or darker than the surrounding field. If it becomes brighter, the glass has a higher refractive index than the liquid. If it becomes darker, the

glass has a lower refractive index than the liquid. In both cases, the opposite will be true when the microscope tube is lowered.

- G. This test can be used to confirm that the beads are above or below a specified index. It can also be used to give an accurate determination of the index, ± 0.001 . This is done by using several refractive index liquids until a match or near match of indices occurs. The index of the glass will equal that of the liquid when no Becke line and no variation in bead brightness can be observed.

720.07.3.3.2--Acid Resistance. The beads shall show resistance to corrosion of their surface after exposure to a 1% solution by weight of sulfuric acid. The 1% acid solution shall be made by adding 5.7 mL of concentrated acid into 1000 mL of distilled water. **CAUTION:** Always add the concentrated acid into the water, not the reverse. The test shall be performed as follows:

Take a 1" x 2" sample, adhere it to the bottom of a glass tray and place just enough acid solution to completely immerse the sample. Cover the tray with a piece of glass to prevent evaporation and allow the sample to be exposed for 24 hours under these conditions. Then decant the acid solution, but do not rinse, touch, or otherwise disturb the bead surfaces, and dry the sample while adhered to the glass tray in a 150°F oven for approximately 15 minutes.

Microscopic examination at 20X shall show no more than 15% of the beads having a formation of a very distinct opaque white, corroded, layer on their entire surface.

720.07.3.4--Color. The preformed pavement markings shall consist of white and yellow films with pigments selected and blended to conform to standard highway colors.

720.07.3.5--Skid Resistance. The patterned surface of the retroreflective pliant polymer shall provide an initial average skid resistance value of 45 BPN when tested according to ASTM Designation: E 303, except values will be taken at downweb and at a 45 degree angle from downweb. These two values will then be averaged to find the skid resistance of the patterned surface.

720.07.3.6--Patchability. The pavement marking material shall be capable of use for patching worn areas of the same type in accordance with manufacturer's instructions.

720.07.3.7--Thickness. The patterned material, without adhesive, shall have a minimum caliper of 0.065 inch at the thickest portion of the patterned cross-section and a minimum caliper of 0.020 inch at the thinnest portion of the cross-section.

720.07.4--Effective Performance Life. The film, when applied according to the

recommendations of the manufacturer, shall provide a neat, durable marking that will not flow or distort due to temperature if the pavement surface remains stable. The film shall be weather resistant and, through normal traffic wear, shall show no appreciable fading, lifting or shrinkage throughout the useful life of the marking, and shall show no significant tearing, roll back, or other signs of poor adhesion.

720.07.5--Manufacturer's Certification. The Contractor shall furnish the Engineer three copies of the manufacturer's certification stating that each lot in a shipment complies with the requirements of the contract.

720.07.6--Acceptance Sampling and Testing. Final acceptance of each lot will be based on results of tests performed by the Department on verification samples submitted from each lot shipped to the project. The Engineer will select one sample at random from each lot in the shipment for testing. A sample extending full width of the randomly selected sample and five linear feet in length will be obtained and submitted by the Engineer. The sample from each shipment shall be provided at no cost to the State.

720.07.7--Warranty. All manufacturer's standard warranties and guarantees on high performance cold plastic pavement marking material, which are provided as customary trade practice, shall be delivered to the Engineer at the final inspection. All warranties and guarantees shall be made out to the Mississippi Department of Transportation.

SECTION 721 - MATERIALS FOR SIGNING

721.01--General. All materials included in this section will be conditionally accepted on the basis of the manufacturer's certification of compliance, as specified in Subsection 106.04, except those materials normally tested by the Department; i.e. concrete, reinforcing steel, timber posts, etc.. The State Materials Engineer shall be furnished the original and three copies of the manufacturer's certification. The Department reserves the right to test or have tested by a commercial laboratory any material that has been conditionally accepted by certification.

721.02--Ferrous Materials.

721.02.1--General. All welds shall be mechanically cleaned before galvanizing. All ferrous metal except reinforcing steel, and sheet steel unless otherwise specified, shall be zinc-coated, galvanized, by the hot dip method in accordance with AASHTO Designation: M 111 after all fabrication has been completed.

721.02.2--Structural Steel for Sign Supports. Structural steel used in sign support structures shall be of standard shape. Structural steel pipe per ASTM

Designation: A 53 shall be manufactured by the open-hearth or basic oxygen process.

721.02.2.1--Ground Mounted Sign Supports. Posts shall be provided with "break-away" mountings as shown on the plans using the following materials:

Structural steel beams for posts per AASHTO Designation: M 160.

Steel plates for steel beam posts per AASHTO Designation: M 160.

Welded and seamless steel pipe for posts per ASTM Designation: A 53, Type E or S, Grade B, or steel structural tubing per ASTM Designation: A 501.

U-Section posts for supplementary directional signs per Subsection 721.02.3 "Steel Posts for Small Signs" modified as shown on the plans.

Structural steel shapes, bars, and plates used for bracing, framing and other accessories, including base plates for steel posts, per ASTM Designation: A 36.

High strength bolts, nuts, and washers for post bases and for fuse plates per Subsections 717.01.7 and 810.02.21 modified as shown on the plans.

721.02.2.2--Overhead Sign Supports. Materials approved for use in the construction of overhead sign supports include the following:

Welded and seamless steel pipe per ASTM Designation: A 53, Type E or S, Grade B or Type F.

Steel structural tubing per ASTM Designation: A 501.

Structural shapes, plates, and bars per ASTM Designation: A 36.

Castings for post base and truss flange per AASHTO Designation: M 106, Grade 35018.

Castings for post caps and chord caps per AASHTO Designation: M 105, Class 25 S.

High strength bolts, nuts, and washers for chord connections per Subsections 717.01.7 and 810.02.21.

Anchor bolts per ASTM Designation: A 307, Grade A.

721.02.3--Steel Posts for Small Signs.

721.02.3.1--Material. The posts shall be of high carbon rail steel ASTM Designation: A 499.

721.02.3.2--Workmanship. All posts shall be straight with no bending, warping, splits, or breaks.

721.02.3.3--Cross-Section. The posts shall be "U" section as shown on the plans. The bends in the cross-section of the post must be sharp and well defined, and the radius of the bend shall not be greater than 13/32 of an inch.

721.02.3.4--Weight. The weight of the posts per linear foot without ground plates, shall be 2.0 pounds for seven-foot and nine-foot lengths and 3.0 pounds for eleven-foot and fourteen-foot lengths with a tolerance of three and one-half percent, or as shown on the plans.

721.02.3.5--Punching. The posts shall be punched on the center line of the web while hot. Posts of 7-foot to 14-foot lengths shall have 3/8-inch holes one inch apart on centers starting one inch from the top of the posts and extending the full length of the post.

721.02.3.6--Pointing. The posts shall not be pointed.

721.02.4--Reinforcing Steel. Reinforcing steel used shall conform to Section 711 and shall be placed in accordance with Section 602.

721.02.5--Bolts, Nuts, Washers, Screws, and other Hardware. Except as otherwise specified, all bolts, nuts, washers, sheet metal screws, and machine screws shall be coated by the zinc chromate process. The zinc chromate process shall be in accordance with the requirements of ASTM Designation: B633. Bolts shall have a 1/2-inch head and shall meet the requirements of ASTM Designation: A307, Grade A. Nuts shall be self-locking and shall meet the requirements of ASTM Designation: A563. Flat washers shall be installed between the sign support and the self-locking nut and shall meet the requirements of ANSI Designation: B27.2. Sheet metal screws shall meet the requirements of ANSI Designation: B18.6.4. Machine screws shall meet the requirements of ANSI Designation: B18.6.3. Vinyl spacers shall be installed between the bolt head and the sign face and shall meet the following maximum dimensions: 7/8-inch outside diameter by 3/8-inch inside diameter by 1/16-inch thickness.

Post clips used with extruded panel signs shall be cast aluminum per ASTM Designation: B 108, Alloy No. 356.0-T6 or extruded aluminum per ASTM Designation: B 221, Alloy 6063-T6. Unless otherwise specified, all bolts, sheet metal screws, and machine screws used in assembling signs, frames, and post braces, including post clips and panel bolts, shall be in accordance with ASTM Designation: A 307, Grade A.

721.03--Aluminum. All aluminum shall be free from corrosion, white rust, water stains, dirt, and grease. Fabrication shall be accomplished in a uniform and workmanlike manner. All fabrication, including cutting and punching of holes, shall be completed prior to metal treatment. Sign blanks shall be cut to size and shape and shall be free of buckles, warps, dents, cockles, burrs, and defects resulting from fabrication. The surface of all sign blanks shall be flat.

All blanks not having corner radii shall have square 90° corners to facilitate sign fabrication.

All blanks requiring holes shall have “MDOT” debossed on the blank in a location so as not to be covered by the post when erected. The debossed letters shall be not less than 3/8 inch high and shall be approximately 0.006 inch deep so as not to be visible on the other side of the blank.

721.03.1--Sheet Aluminum. Sheet aluminum or blanks shall meet the requirements of ASTM Designation: B 209, Alloy 6061-T6 or 5052-H38. Gauge, dimension, punching and corner radii shall be in accordance with the plans.

721.03.2--Extruded Signs. Extruded sign panels, extruded moldings, and extruded post clips shall meet the requirements of ASTM Designation: B 221, Alloy 6063-T6. Sections and dimensions shall be as shown on the plans. The panel shall be of the butt type, designed to withstand a wind pressure of 50 pounds per square foot. All panels shall be flat and straight within commercial tolerances as established by the aluminum industry. Extruded sign sections shall be subject to approval by the Engineer. Extruded sign sections shall be provided with slotted bolt holes. Sign moldings and post clips shall be designed for the sign panel section with which it is used. Sign moldings shall be anchored to the sign panels by means of aluminum pull-through rivets or self-tapping screws.

721.03.3--Overhead Sign Support Material. Material approved for use in the construction of Overhead Sign Supports include the following:

Extruded structural tube and pipe per ASTM Designation: B 221, B 241 or B 429, Alloy 6061-T6.

Extruded structural tube and pipe per ASTM Designation: B 221, B 241 or B 429, Alloy 6063-T6.

Structural shapes per ASTM Designation: B 308, Alloy 6061-T6.

Sheet and plate per ASTM Designation: B 209, Alloy 6061-T6.

Castings for post and chord caps per ASTM Designation: B 26, Alloy No. 356.0.

Base and filler metals for welding shall be as listed below:

<u>Base</u>	<u>Filler</u>
<u>Metal Alloys</u>	<u>Metal Alloys</u>
6061-T6 to 6061-T6	ER-5556
6063-T6 to 6061-T6	ER-4043, ER-5356
or 6063-T6	or ER-5556

721.04--Concrete. Unless otherwise specified, concrete shall be Class B. Composition, manufacture, and placement shall be in accordance with Section 601.

721.05--Colors and Paint. All colors for signs shall match FHWA specifications for standard highway sign colors.

The molding which is attached to the extruded panel signs shall be painted with a semi-gloss baking enamel meeting Federal Specification TT-E-529a.

Aluminum paint shall conform to Subsection 710.02.1.

Transparent and black opaque process colors used in silk screening shall be that or equal to that recommended by the manufacturer of the retroreflective sheeting, and shall match FHWA Specifications for standard highway sign colors. Toning of certain colors for adjustment in hue shall be accomplished in accordance with the recommendations of the manufacturer of the process paste.

721.06--Reflective Sheeting.

721.06.1--General. Retroreflective sheeting materials shall comply with all applicable requirements of ASTM Designation: D 4956, except as specifically modified herein, and be listed on the Department's "Approved Sources of Materials".

Reflective sheeting shall be one of the following types.

Type III. A high-intensity retroreflective sheeting. This shall be an encapsulated glass-bead or unmetallized microprismatic retroreflective material. This sheeting shall have a protected, pre-coated, pressure-sensitive adhesive backing.

Type VII. A super high-intensity retroreflective sheeting. This shall be an unmetallized microprismatic retroreflective material. This sheeting shall have a protected, pre-coated, pressure sensitive adhesive backing.

Type VIII. A super high-intensity retroreflective sheeting. This shall be an unmetallized microprismatic retroreflective material. This sheeting shall have a protected, pre-coated, pressure sensitive adhesive backing.

Type IX. A very-high intensity retroreflective sheeting. This shall be an unmetallized, microprismatic retroreflective material. This sheeting shall have a protected, pre-coated, pressure sensitive, adhesive backing.

All other retroreflective sheeting shall be as shown in the plans.

721.06.2--Performance Requirements. The retroreflective sheeting shall have the following minimum brightness values at 0.2° and 0.5° observation angle, in addition 1.0° for Type IX sheeting, expressed as average candelas per footcandle per square foot of material.

Sheetings and inks processed and applied in accordance with the manufacturer’s recommendations, shall perform effectively for the number of years stated below. The sheeting will be considered unsatisfactory if it has deteriorated due to natural causes to the extent that: (1) the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving conditions or (2) the coefficient of retroreflection is less than the minimum specified for that sheeting during the periods listed below. For screen printed transparent colored areas on white sheeting, the coefficients of retroreflection shall not be less than 70% of the values for the corresponding color in the table.

Type III Sheeting Retain 85% of initial values listed in Table 1 through 7 years
Retain 80% of initial values listed in Table 1 between 7 & 10 years

Type VII Sheeting Retain 85% of initial values listed in Table 2 through 7 years
Retain 80% of initial values listed in Table 2 between 7 & 10 years
Retain 50% of initial values listed in Table 2 through 3 years for Fluorescent Orange

Type VIII Sheeting Retain 85% of initial values listed in Table3 through 7 years
Retain 80% of initial values listed in Table 3 between 7 & 10 years
Retain 50% of initial values listed in Table 3 through 3 years for Fluorescent Orange
Retain 80% of initial values listed in Table 3 through 7 years for Fluorescent Yellow/Green & Fluorescent Yellow

<u>Type IX Sheeting</u>	Retain 85% of initial values listed in Table 4 through 7 years
	Retain 80% of initial values listed in Table 4 between 7 & 10 years
	Retain 80% of initial values listed in Table 4 for 7 years for Fluorescent Yellow/Green & Fluorescent Yellow

MINIMUM COEFFICIENTS OF RETROREFLECTION

Candela per foot candle per square foot (cd/ft/ft²)

Per ASTM Designation: E 810

TABLE 1
Type III Sheeting

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown
0.2°	-4°	250	170	100	45	45	20	12
0.2°	+30°	150	100	60	25	25	11	8.5
0.5°	-4°	95	62	30	15	15	7.5	5.0
0.5°	+30°	65	45	25	10	10	5.0	3.5

TABLE 2
Type VII Sheeting

Observation Angle	Entrance Angle	White	Yellow	Green	Red	Blue	Brown	Fluorescent Orange
0.2°	-4°	750	560	75	150	34	23	200
0.2°	+30°	430	320	43	86	20	10	85
0.5°	-4°	240	180	24	48	11	8	90
0.5°	+30°	135	100	14	27	6.0	4	50

MINIMUM COEFFICIENTS OF RETROREFLECTION

Candela per foot candle per square foot (cd/ft/ft²)

Per ASTM Designation: E 810

TABLE 3
Type VIII Sheeting

Observation Angle	Entrance Angle	White	Yellow	Green	Red	Blue	Brown	Fluorescent Orange	Fluorescent Yellow/ Green	Fluorescent Yellow
0.2°	-4°	700	525	70	105	42	21	200	480	375
0.2°	+30°	325	245	33	49	20	10	85	240	170
0.5°	-4°	250	190	25	38	15	7.5	90	235	165
0.5°	+30°	115	86	12	17	7	3.5	50	110	85

TABLE 4
Type IX Sheeting

Observation Angle	Entrance Angle	White	Yellow	Green	Red	Blue	Fluorescent Yellow / Green	Fluorescent Yellow
0.2°	-4.0°	380	285	38	76	17	325	240
0.2°	+30.0°	215	162	22	43	10	205	150
0.5°	-4.0°	240	180	24	48	11	240	165
0.5°	+30.0°	135	100	14	27	6.0	110	75
1.0°	-4.0°	80	60	8	16	3.6	65	45
1.0°	+30.0°	45	34	4.5	9	2.0	35	25

721.06.3--Certification. The Contractor shall require the supplier to furnish certified evidence and/or samples to the Engineer showing conformance to these requirements. Manufacturer's warranties or guarantees provided as customary trade practice shall be furnished the Department.

721.06.4--Color. Reflective sheeting shall meet the color requirements of ASTM Designation: D 4956. See Table 5 below for color specifications for fluorescent yellow green, fluorescent orange, and fluorescent yellow sheeting.

TABLE 5
Color Specification Limits for New Sheeting - Daytime

Color	Chromaticity Coordinate 1	Chromaticity Coordinate 2	Chromaticity Coordinate 3	Chromaticity Coordinate 4	Total Luminance Factor Limit Y _T Min.
	x y	x y	x y	x y	
Fluorescent Yellow Green	0.387 0.610	0.460 0.540	0.438 0.508	0.376 0.568	60%
Fluorescent Orange	0.562 0.350	0.645 0.355	0.570 0.429	0.506 0.404	30%
Fluorescent Yellow	0.521 0.424	0.557 0.442	0.479 0.520	0.454 0.491	40%

721.06.5--Adhesive. The retroreflective sheeting shall include a pre-coated pressure sensitive adhesive, as referenced in ASTM Designation: D 4956, Class I, applied without the necessity of additional adhesive coats on the retroreflective sheeting or application surface.

The Class I adhesive shall be a pressure sensitive adhesive of the aggressive tack type requiring no heat solvent or other preparation for adhesion to smooth clean surfaces.

The protective liner attached to the adhesive shall be removed by peeling without soaking in water or other solutions and shall be easily removed after accelerated storage for four hours at 160°F under a weight of 2.5 pounds per square inch.

721.06.6--Additional Contract Requirements. This Subsection is applicable only when the sheeting material is being purchased for use in the MDOT Sign Shop. In addition to the above requirements, the following requirements must also be met.

721.06.6.1--Sheeting Manufacturer’s Replacement Obligation. Where it can be shown that retroreflective traffic signs with Type III, Type VII, Type VIII, or Type IX sheeting supplied and used according to the sheeting manufacturer’s recommendations have not met the performance requirements, the sheeting manufacturer shall replace the sheeting required to restore the sign surface to its original effectiveness during the entire 10 years. In addition, during the first seven (7) years the manufacturer of Type III, Type VII, Type VIII, or Type IX sheeting shall cover the cost of restoring the sign surface to its original effectiveness at no cost to the Department for materials and labor for both sign

manufacture and installation.

721.06.6.2--Technical Assistance Requirements.

Instruction and Training. The manufacturer supplying the retroreflective sheeting shall provide at no additional cost the services of a qualified technician for instruction and training at the sign manufacturing facility. This instruction shall be provided bi-annually or when requested, and shall include but not be limited to training films, material application, equipment operation, silk screening techniques, packaging, storage, and other proven sign shop practices as they apply to the retroreflective sheeting supplied by the manufacturer, and to assure that the resulting signs can comply with the applicable specifications.

Technical Service. The sheeting manufacturer shall, without additional cost to the Department, provide the sign shop with competent technical service and product information including service on screen printing problems with the inks furnished by the manufacturer.

Equipment. The manufacturer supplying the retroreflective sheeting shall provide technical assistance for the recommended sheeting application equipment and certify that trained personnel shall be available on 72 hours notice to render such service necessary to adjust ink consistency or otherwise modify the application of silk screen equipment to accommodate use of manufacturer's sheeting. "Service" is understood to mean the capability of calibration and trouble shooting, as well as the training and retaining of personnel as required.

721.06.6.3--Warranty. Any warranties prepared by the manufacturer shall be included with the bid documents.

721.07--Delineators. Delineators shall consist of encapsulated lens reflective sheeting of the specified colors applied to sheet metal with mechanical equipment in a manner specified by the sheeting manufacturer. The sheet metal shall be the same as that used for small sheet signs as required under Subsection 721.03.1.

721.07.1--Flexible Posts. Flexible posts for delineators shall be composed of high impact fiberglass reinforced composite, engineering blended plastic or thermosetting polymers which is reasonably unaffected by long term U.V. exposure.

Flexible posts for delineators must be one from the Department's "Approved Sources of Materials". Prior to use, the Contractor shall furnish the Engineer three copies of the manufacturer's certification for each shipment stating that the material furnished is of the same composition as that originally approved by the Department and that the material has not been changed or altered in any way.

721.07.1.1--Performance Testing for Flexible Posts.

721.07.1.1.1--Impact Resistance. The post must be self erecting after withstanding 10 vehicle impacts at temperatures of 0°F or above without complete loss of serviceability. The impacts shall be made at an impact angle of $25 \pm 5^\circ$ with a sedan at 35 mph.

721.07.1.1.2--Heat Resistance. A post shall be conditioned a minimum of two hours in an oven at $115^\circ \pm 3^\circ\text{F}$. The conditioned post shall be capable of straightening itself within 10 seconds when bent 90° at or near midpoint for each of four bends. The test on each post shall be completed within two minutes after removal from the oven. The post shall be bent in the direction to form a 90° angle on the convex side of the post.

721.07.1.1.3--Cold Resistance. A post shall be conditioned a minimum of two hours at $-5^\circ \pm 3^\circ\text{F}$ in an environmentally controlled test chamber. Testing shall be performed in the environmental chamber. The conditioned post shall not be adversely effected when bent at or near midpoint to a 90° angle formed on the convex side of the post. The post shall return to its original shape within 60 seconds for each of four separate bends.

721.07.1.1.4--Color Fastness. The post materials shall be exposed for 1000 hours in an Atlas Type B or BH Xenon Arc Weatherometer per ASTM Designation: G 26 with no significant yellowing or darkening.

721.07.1.2--Acceptance Procedure. Flexible posts for delineators must be one from the Department's "Approved Sources of Materials". Prior to use, the Contractor shall furnish the Engineer three copies of the manufacturer's certification for each shipment stating that the material furnished is of the same composition as that originally approved by the Department and that the material has not been changed or altered in any way.

721.08--Removable Copy. Removable copy shall include letters, numerals, symbols, and borders. The designs for the capital and lower case alphabets shall conform to that recommended by the Federal Highway Administration. The initial letters and numerals will be Series E modified or as specified on the plans. All removable copy will be attached to the sign face from the front by means of a huck or a cherry rivet gun and aluminum pull-through rivets without the use of clips. Removable copy shall consist of encapsulated lens silver retroreflective sheeting which has been carefully selected by the manufacturer for uniformity of day and night appearance and applied to flat aluminum backing. The backing shall be a minimum of .032" thick aluminum sheet as per ASTM Designation: B 209, alloy 3003-H14. The metal treatment shall be the same as that for aluminum sheet.

721.09--Timber Sign Posts. The posts shall conform to the requirements set forth in Subsection 712.05.1.3, except that the preservative shall conform with Subsections 718.04.3 or 718.04.4.

721.10--Direct Applied Copy. Direct applied copy which is to be provided on guide directional signs, ground mounted or overhead , shall be directly applied to the sign face. Direct applied copy shall include letters, numerals, symbols and borders. The designs for capital and lower case shall be as required by the plans. All type of copy other than caps and lower case shall be as required by the plans. All type faces/fonts shall conform to the recommendations contained in standards published by the Federal Highway Administration. All direct applied copy shall be attached to the sign face by means of pressure sensitive adhesive meeting the requirements of Subsection 721.06.5--Adhesive. Direct applied copy shall consist of encapsulated lens silver retroreflective sheeting meeting the requirements of Subsection 721.06--Reflective Sheeting.

All signs shall be delivered to the site of their erection in one piece with all bolts, rivets, moldings, extrusions, copy, and other required appurtenances thereto attached, complete and ready to be mounted to the sign support structure. Any required supplemental or temporary supports required for stability during transport shall be firmly attached but easily removed prior to erection.

SECTION 722 - MATERIALS FOR TRAFFIC SIGNAL INSTALLATION

722.01--General. Acceptance of all material in this Section is subject to Subsections 106.01 and 106.04 entitled "Source of Supply and Quality Requirements" and "Certification of Compliance", respectively.

722.02--Poles. The various pole types are as follows: Type I-Strain, Type II-Single Mast Arm, Type III-Double Mast Arm, Type IV-Strain and Mast Arm Combination, Type V-Pedestal Pole for Traffic Signal, Type VI-Pedestal Pole for Pedestrian Signal, Type VII-Pedestal Pole for Detector Equipment Cabinet. Determination of required sizes, lengths, and gauges of Type I, II, III, and IV steel poles shall be the responsibility of the Contractor in accordance with the plans and Specifications.

Type I, II, III and IV poles shall be steel meeting the requirements of Subsection 722.02. Type V, VI, and VII poles shall meet the requirements of Subsection 722.15.

722.02.1--General. These specifications are for aluminum, steel, concrete and wood poles for use as signal equipment supports, and other support structure as required.

722.02.1.1--Taper. All poles shall have a constant taper from bottom to top and may be round or polyhedral.

722.02.1.2--Type Mountings. The type mounting shall be either aluminum, steel, concrete, or wood as indicated on the plans.

Aluminum, steel, or concrete shall have either precast butts for direct mounting in the earth or attached base mounts for mounting on concrete foundations or on break-away bases.

Wood poles shall be mounted directly in the earth.

722.02.1.3--Design Strength Requirements. The design strength requirements for the support structure shall be in accordance with the AASHTO design specification, the plans, and for the wind load as indicated on the plans. The support structure shall consist of the pole, anchor bolts, base plate, mast arm, and other supporting devices.

722.02.1.4--Design Calculations and Data or Manufacturer's Certifications. The Contractor shall submit for approval by the Engineer, five copies of the information listed below to certify that the support structure is designed to meet the above requirements.

722.02.1.4.1--The Manufacturer's Certification.

722.02.1.4.2--Design Calculations and Data.

- (a) Complete detailed drawings identifying and describing each member of the support structure and the guaranteed minimum yield and ultimate strengths.
- (b) Specifications for fabrications and erections of the structure.
- (c) Complete design calculations.
- (d) Where design procedure is derived from computer programs, computer read-outs may be submitted in lieu of design calculations required above provided a detailed example of a typical problem showing the necessary calculations performed is included along with the computer read-outs.

722.02.1.5--Handhole. All steel and aluminum poles not mounted on breakaway transfer bases shall have a minimum of four by six inch reinforced handhole. A grounding nut that will accommodate a one-half inch, 13 UNC threaded bolt or stud shall be installed inside the pole.

722.02.2--Aluminum Poles-Conventional.

722.02.2.1--Poles. The poles shall be spun or formed from aluminum seamless tubing meeting requirements of ASTM Designation: B 210, Alloy 6063-T4 and after fabrication shall have mechanical properties not less than those specified for Alloy 6063-T6. The poles may also be formed from aluminum plates or sheets meeting the requirements of ASTM Designation: B 209, Alloys 5052-H34 or

5086-H34.

722.02.2.2--Castings. Castings shall be in accordance with ASTM Designation: B 108 or B 26 Structural Alloy, ANSI 356.0 UNS A03560-T6, Non-Structural Alloy, ANSI B443.0 UNS A24430. The structural, one-piece base castings shall be provided with four slotted holes to receive the anchor bolts, and tapped holes for attaching the removable cover. The base shall telescope and be affixed to the lower end of the shaft with two continuous welds made by the metallic-arc-consumable electrode-inert gas-shielded process, one inside of the base at the end of the shaft, the other outside the top of the base.

722.02.2.3--Covers and Caps. Approved removable bolt covers shall be provided and attached to the upright portion of the base by means of stainless steel hex head screws. Shaft and mast arm caps shall be fastened with stainless steel hex head screws.

722.02.2.4--Finish. External surface of shafts shall have a satin-type finish, clean and smooth, with all details defined and true to pattern.

722.02.3--Steel Poles-Conventional.

722.02.3.1--Poles. The poles shall be formed from commercial quality carbon steel with a yield strength of 55,000 psi, ASTM Designation: A 595, for round poles; and a yield strength of 50,000 psi, ASTM Designation: A 1011, for multi-sided poles.

The shaft shall be galvanized in accordance with the requirements of ASTM Designation: A 123.

The shaft shall have a taper from 0.10 to 0.14 inch per foot.

722.02.3.2--Base Plate. The poles shall be equipped with either a structural quality hot rolled carbon steel plate with a minimum yield strength of 36,000 psi, ASTM Designation: A36, or low alloy steel plate with a minimum yield strength of 42,000 psi, ASTM Designation: A572. The base plate shall telescope the shaft and affix to the shaft with two continuous electric arc welds; one on the inside of the base plate at the end of the shaft, the other on the outside at the top of the base plate. The base plate shall be galvanized in accordance with ASTM Designation: A 123.

722.02.3.3--Covers and Caps. Approved removable bolt covers and caps shall be provided and attached to the shaft with self-threading stainless steel hex head screws.

722.02.4--Concrete Poles.

722.02.4.1--General. Concrete poles shall be precast, machine made in steel forms by the centrifugal process to produce dense concrete members of the dimensions and design shown on the plans, and in accordance with these specifications. The shaft shall be tapered, octagonal or circular in cross section with a smooth outer finish.

722.02.4.2--Aggregate. All aggregate shall be graded from 3/8 inch to No. 100 sieve, with not more than 10 percent passing the No. 100 sieve. Characteristics of aggregates, other than gradation, shall comply with the requirements of Section 703.

722.02.4.3--Cement. Portland Cement used in the manufacture of poles shall conform to the requirements of Section 701.

722.02.4.4--Water-Cement Ratio. Water used shall conform to the requirements of Subsection 714.01.2. The water-cement ratio shall be in the proportion required to produce concrete with a minimum compressive strength of 3,500 psi, in 24 hours after curing. Test data shall be furnished to the Engineer, when requested.

722.02.4.5--Reinforcement. Either prestressed or conventional reinforcement meeting the requirements of Sections 602, 711 and 804 may be used. Prestressed poles shall be reinforced with high tensile prestressing steel having an ultimate strength of at least 240,000 psi, prestressed to at least 60 percent and not more than 70 percent of ultimate strength. When additional reinforcing is used to meet special requirements it shall be of intermediate grade steel. Conventionally reinforced poles shall contain deformed bars having an ultimate tensile strength of 145,000 psi. Wire for the spiral wind shall have a minimum diameter of 87/1000 inch with 260,000 psi. Reinforcing bars shall be assembled in a cage with rods evenly spaced from one another with attached concrete spacers to insure a minimum concrete cover of 9/16 inch. The spiral wind shall be one continuous wire wrapped around the cage with maximum spacing of 1½ inches between spirals.

722.02.4.6--Method of Manufacture. Poles shall be cast in metal forms true to design, including integral butts when specified.

Concrete shall be mixed not less than five minutes, and shall be placed in one continuous operation. When filled, the mold shall be rotated at high speed to insure a dense concrete by centrifugal force and provide a cable raceway of not less than 1 3/4 inch in diameter, extending throughout the length of the pole. The finished poles shall have smooth surfaces.

Following the casting operation the concrete shall be cured with low temperature steam.

722.02.4.7--Precast Butt. When specified on plans, an integral butt foundation shall be cast with the pole in the spinning process. When so cast, the pole shall be provided with a minimum of 2½-inch by 6-inch handhole with approved cover, located 18 inches above ground line. A minimum of 9-inch by 2½-inch cable entrance shall be provided 18 inches below ground line.

722.02.5--Wood Poles. The wood poles shall meet the requirements of the latest edition of ANSI-05.1, "American National Standard for Wood Poles - Specifications and Dimensions", for Southern pine poles having a fiber stress of 8,000 psi. The dimensions of the poles shall be as specified in the table below. The poles shall be inspected and treated in accordance with Section 718.

DIMENSIONS OF SOUTHERN PINE POLES

Class		1	2	3	4	5	6	7	9	10
Minimum Circumference at top, Inches		27	25	23	21	19	17	15	15	12
Length of Pole, Feet	Groundline* Distance from Butt, Feet	Minimum Circumference at Six Feet from Butt, Inches								
20	4	31.0	29.0	27.0	25.0	23.0	21.0	19.5	17.5	14.0
25	5	33.5	31.5	29.5	27.5	25.5	23.0	21.5	19.5	15.0
30	5.5	36.5	34.0	32.0	29.5	27.5	25.0	23.5	20.5	
35	6	39.0	36.5	34.0	31.5	29.0	27.0	25.0		
40	6	41.0	38.5	36.0	33.5	31.0	28.5			
45	6.5	43.0	40.5	37.5	35.0	32.5	30.0			
50	7	45.0	42.0	39.0	36.5	34.0				
55	7.5	46.5	43.5	40.5	38.0					
60	8	48.0	45.0	42.0	39.0					
65	8.5	49.5	46.5	43.5	40.5					
70	9	51.0	48.0	45.0	41.5					
75	9.5	52.5	49.0	46.0						
80	10	54.0	50.5	47.0						
85	10.5	55.0	51.5	48.0						
90	11	56.0	53.0	49.0						
95	11	57.0	54.0							
100	11	58.5	55.0							
105	12	59.5	56.0							
110	12	60.5	57.0							
115	12	61.5	58.0							
120	12	62.5	59.0							
125	12	63.5	59.5							

* The figures in this column are intended for use only when a definition of groundline is necessary in order to apply requirements relating to scars, straightness, etc.

722.03--Electric Cable. The cable shall be high-grade insulated conductors of first class material and workmanship manufactured in accordance with the best engineering practices, suitable for use in trays, ducts, conduit, aerial direct burial application. It shall be accessible to Department representatives for inspection at all reasonable times. In lieu of such inspection, the Department may require that three certified copies of factory tests be furnished.

The materials used for electrical conductors, insulation, jacket armoring and covering shall meet the requirements as indicated on the plans and these requirements.

Cable shall be of the following types with number of conductors and conductor size as indicated on the plans.

Signal Cable. Polyethylene insulated, polyethylene jacketed cable rated at 600 volts meeting the requirements of IMSA Specification No. 20-1, 1984, and with integral messenger cable meeting the requirements of IMSA Specification No. 20-3, 1984.

Power Cable. High density polyethylene covered drawn copper line wire meeting the requirements of IMSA Specification No. 26-3, 1973.

Communication Cable. Paired polyethylene insulated, polyethylene jacket cable with electrical shielding rated at 300 volts meeting the requirements of IMSA Specification No. 40-2, 1984, with integral messenger cable meeting the requirements of IMSA Specification No. 40-4, 1984.

Loop Detector Lead-In Cable. Shielded cable conforming to IMSA Specification No. 50-2, 1984, for polyethylene insulated, polyethylene jacketed loop detector lead-in cable. Unless otherwise indicated, the cable shall be 2-conductor,, AWG # 14.

Loop Detector Wire. Cross-linked polyethylene insulated loop detector wire rated at 600 volts meeting the requirements of IMSA Specification No. 51-3, 1984.

Tracer Cable and Warning Tape. Tracer cable shall be Type THHN, annealed copper, insulated with high-heat and moisture resistant PVC, jacketed with abrasion, moisture, gasoline, and oil resistant nylon, or UL-listed equivalent. The cable shall be AWG# 10 with 19 strands and a 20-mil insulation thickness. It shall be suitable for operations at 600 volts as specified in the National Electrical Code. The warning tape shall be a non-detectable commercial warning tape approved by the Engineer.

722.04--Messenger Cable. Messenger cable for aerial support of electric cable, traffic signal conduit, traffic signal devices, etc. shall conform to the

requirements of ASTM Designation: A 475 for 3/8 inch seven-strand utilities grade with Class "B" zinc coating. Brackets and/or other devices for aerial support shall be in accordance with details shown on the plans or approved by the Engineer.

Tether cable shall conform to the requirements of ASTM Designation: A 475 for 1/4-inch, 7-strand Siemens-Martin grade with Class "B" zinc coating.

722.05--Traffic Signal Conduit.

722.05.1--General. The traffic conduit shall be of the following types and indicated in the plans.

722.05.2--Type I Rigid Galvanized Steel. Rigid galvanized steel meeting the requirements of American Standards Association (ASA) Specifications C 80.1.

722.05.3--Type II Rigid Copper Nickel, Steel Alloy, Hot Dip Galvanized. Rigid copper nickel, steel alloy, hot dip galvanized containing 1.6 to 2.2 percent nickel and zero point 0.75 to 1.25 percent copper conforming to American Standard Association (ASA) Specification C 80.1 and Federal Specification WW-C-581.

722.05.4--Type III or Type IV Rigid Non-Metallic Conduit. Rigid non-metallic conduit shall be polyvinyl-chloride (PVC) meeting ASTM Designation: D 1785, as well as National Electric Manufacturers Association (NEMA) Publication TC-2.

722.05.5--Flexible Conduit. Flexible conduit shall be a smooth wall, high density polyethylene conduit designed to be used for cable. Unless otherwise approved by the Engineer, the conduit shall meet the requirements of ASTM Designations: D 2447, D 3035, D 3485, D 2239 and NEMA TC7.

722.05.6--Poly Vinyl Chloride (PVC) Coated Conduit. In addition to the above requirements for conduit, PVC coated conduit shall meet the requirements of UL 6 and NEMA RN1. The conduit shall be coated on the exterior by a 40-mil thick coating of PVC and on the interior by a 2-mil thick coating of urethane. All fittings for PVC coated conduit shall meet the requirements of UL 514B and NEMA RN1 and have the same coating type and thickness. Any component of the PVC conduit which has been scratched before or during the installation process shall be patched with a factory approved sealer.

722.05.7--Roll Pipe Conduit.

722.05.7.1--General. Roll pipe conduit, or duct, shall be manufactured from virgin high density polyethylene. The addition of clean rework material is permissible if generated in the manufacturer's own plant. The ducts shall be

supplied with either smooth, ribbed or corrugated walls and available in a multitude of colors. The duct shall be capable of being coiled or reeled in continuous lengths, transported, stored outdoors and subsequently uncoiled for installation without affecting its properties or performance.

722.05.7.2--Environmental Performance. The duct shall perform in underground and above-ground installations in an ambient temperature range of minus 30°F to 130°F without degradation of material properties. The duct specified for aerial installation shall be ultraviolet light-resistant. The duct shall be capable of being bent to a minimum supported radius of 10 diameters.

722.05.7.3--Workmanship. The duct shall be free of visible cracks, holes or other physical defects that would degrade its performance. It shall be as uniform as practicable in respect to overall dimensions, color, density, thickness, etc.

722.05.7.4--Color. The duct for exposed areas shall have a minimum of carbon black. All other colors shall have a UV light stabilizer which will protect the duct for a minimum of 12 months in direct sunlight.

722.05.7.5--Markings. The duct shall have a durable identification showing the name or trademark of the manufacturer, duct size, date and reference code; i.e., 2-inch IPS SCH-80. Duct for electrical cable should have "CAUTION – HIGH VOLTAGE" printed at regular intervals.

722.05.7.6--Capping. The open ends of each length of reeled duct shall be sealed by plastic caps to prevent the entrance of dirt and/or moisture.

722.05.7.7--Dimensions. The dimensions of the duct shall be as per ASTM Designation: D 3035. Wall thickness to be identified by either SDR, SIDR or SCH ratings. The manufacturer should advise the wall thickness required for a particular installation and/or conditions.

722.05.7.8--Pull Rope and Lubricant. The duct should be equipped with a factory installed rope or tape and prelubed to aid in the installation of cable. The rope can be provided with varying strengths as needed for a particular installation.

722.05.7.9--Couplings. Couplings should be available to quickly connect the duct and should be air and water-tight; i.e. Duct-Lok type couplings in either plastic or aluminum, depending on type of installation.

722.05.7.10--Packaging. The duct should be provided on lightweight metal reels in maximum lengths possible with no joints or splices. This will keep coupling requirements to a minimum. Special reel sizes and/or dimensions should be available for special installations.

722.05.7.11--Corrosion. The duct shall be resistant to most harsh chemicals and/or protected against degradation due to oxidation or general corrosion.

722.05.7.12--Installation. The duct shall be capable of being direct buried by plowing or trenching with no special consideration to using selective backfill. The duct shall also be capable of being encased in concrete pulled through a drilled hole.

722.05.7.13--Tests on Resins and Finished Duct. Lab tests on resins and finished products shall include, but are not limited to, the following:

ASTM Designation: D 3035, Polyethylene Plastic Pipe Based on Controlled Outside Diameter

ASTM Designation: D 1238, Flow Rates of Thermoplastics by Extrusion Plastometer

ASTM Designation: D 1505, Density of Plastics by the Density Gradient Technique

ASTM Designation: D 1693, Environmental Stress Crack Resistance (ESCR) of Polyethylene Pipe

ASTM Designation: D 1599, Short-Time Hydraulic Failure Pressure of Plastic Pipe

ASTM Designation: D 638, Tensile Properties of Plastics

ASTM Designation: D 2444, Impact Resistance of Plastic Pipe by Means of Tup.

ASTM Designation: D 2412, External Loading of Plastic Pipe

722.06--Pull Boxes. Pull boxes shall meet one of the following specifications:

- (a) Cast iron, ASTM Designation: A 48; Hot Dipped Galvanized, ASTM Designation: A 153
- (b) Precast, Class "B" concrete
- (c) Cast Aluminum, ASTM Designation: B 108, SG70-T6
- (d) Welded Aluminum, A1002-6061-T6
- (e) Composite

All pull boxes shall be in accordance with the detail drawings on the plans.

The boxes shall have a gasketed cover secured by set screws or bolts and shall be the type indicated on the plans meeting the following requirements.

Type 1 - Minimum Dimension: 8" x 8" x 6"

Type 2 - Minimum Dimension: 15" x 25" x 12"

Type 3 - Minimum Dimension: 16" x 12" x 12"

Type 4 - Minimum Dimension: 24" x 36" x 18"

Type 5 - Minimum Dimension: 30" x 48" x 18"

The words "Traffic Signal", "Traffic", "Signal", "Fiber Optics", etc. shall be inscribed on top of the covers as applicable.

722.07--Circuit Breakers. Circuit breakers shall be full magnetic with the required A.C. voltage rating and shall have sufficient capacity to interrupt the specified amps at different voltages. The "known" instantaneous trip point shall be no greater than ten times the rating in amperes. They shall be such that the instantaneous trip point and the continuous current rating are unaffected by change in the ambient temperature. Tripping and the time delay characteristics shall be actuated by changes of the magnetic flux. They shall have built-in flash protection to prevent damage due to high resistance faults and a quick break when tripping automatically. The operating handle shall be trip-free so that contact cannot be held closed against short circuit or abnormal over-load. Breakers shall indicate plainly the "ON" and "OFF" positions.

Each breaker shall be molded in a separate case and shall be independently removable from the enclosure for inspection and replacement.

722.08--Terminal Blocks. Each field wiring terminal block shall be of the heavy-duty pressure connector type with minimum rating of 35 amperes, 600 volts RMS, 60 Hz, and shall have a phenolic base, marking strip and corrosion resistant metal parts. Terminal screws shall be no smaller than size 10-32. Marking strips shall have permanent symbols including wire color as shown on the plans.

All working connections in the fixtures shall be terminated on molded, phenolic, barrier type, terminal blocks rated at 15 amperes, 600 volt, and shall have integral type white waterproof marking strips. All current carrying parts of the terminal blocks shall be insulated from the fixture with integral plugs or strips to provide an insulating value in excess of the line-to-ground flashover voltage. If the Contractor elects to use sectionalized terminal blocks, each section shall be provided with an integral barrier on each side and shall be capable of rigid mounting and alignment.

722.09--Grounding and Ground Rods. Ground rod shall be of copper-weld or an equivalent rust-resisting material of the length and diameter shown on the plans. Clamp for ground rod shall be of copper, bronze, or equivalent material. All ground wire shall be AWG No. 6 bare copper wire.

722.10--Expansion Joints. The expansion connection joint shall have an outer covering of flexible bronze or stainless steel wire braid over a flexible core of the same metal and an insulating liner. The end fitting shall be bronze or stainless steel. The expansion joint shall be UL listed.

722.11--Miscellaneous Hardware. All bolts other than those specified in Subsection 722.12, nuts, washers and other miscellaneous hardware shall be galvanized steel, stainless steel, or aluminum unless otherwise indicated on the plans. Galvanizing may be hot-dipped or by a mechanical method all in accordance with ASTM Designation: A 153 except for method of coating.

722.12--Anchor Bolts. The foundation anchor bolts shall have the strength requirements as specified in Subsections 722.02.1.3 and 722.02.1.4. Galvanizing conforming to ASTM Designation: A 153 shall be required for the full length of the threaded section plus an additional six inches of the foundation anchor bolts.

722.13--Detector Equipment Cabinets and Controller Cabinets. All cabinets shall be a NEMA Type 4 enclosure, based on NEMA standard No. 250-1985, "Enclosures for Electrical Equipment." Cabinets shall be fabricated from a minimum thickness of 0.125 inch aluminum alloy sheet meeting the requirements in ASTM Designation: B 209, for Alloy 5052, temper H32.

The cabinet shall have a minimum dimension of 20 inches high by 16 inches wide by 12 inches deep, and shall house without crowding 10 vehicle loop detectors, terminal blocks as required, circuit breaker, grounding studs, surge protection, and any other equipment necessary for a complete installation.

The cabinets shall have:

- 1) drilled and tapped bosses as required,
- 2) a screened breather at the top and at the bottom,
- 3) shelves or other suitable means of holding the equipment,
- 4) a solid grounding system by means of the pole ground system upon which the cabinet is mounted,
- 5) provisions for pole or pedestal mounting as required on the plans, and
- 6) a surge protection device for each detector amplifier to be housed in the cabinet.

The surge protection devices must be a three terminal device capable of protecting the detector against differential surges and common mode surges. It must be of the inductive type with a maximum DC resistance of 150 milliohms,

and an inductance of at least 4 millihenries. It must be capable of withstanding repeated 400 ampere surges. The device must be a two stage device capable of clamping a 250 ampere surge to 25 volts within 40 nanoseconds with the surge applied across the two detector leads. It must clamp a 250 ampere common mode surge to 35 volts.

722.14--Signal Heads.

722.14.1--Traffic Signal Heads - Conventional. Conventional traffic signal heads shall consist of all component materials necessary to form heads as specified on the plans and shall be complete with attachments for pole mounting, span wire mounting or mast arm mounting, as indicated, and for tie-ins to the feeder cable.

These signal heads shall meet the requirements of the latest ITE standards for Adjustable Face Vehicle Traffic Control Signal Heads, the National Electrical Code and the Manual on Uniform Traffic Control Devices where applicable.

No splicing of electric cables will be allowed exterior to the signal head. Quick disconnect hangers will be required where electric cables are too large to enter and leave the normal wire entrance fitting. However, in any signal installation, if one signal head requires quick disconnect hangers then all heads on that installation will be furnished with quick disconnect hangers.

722.14.1.1--Housing.

722.14.1.1.1--Materials. Each housing shall be made of one of the following materials:

- (a) Cast from aluminum alloy. Material for die cast housings shall be aluminum alloy S-12A, S-12B, SC-84A, SC-84B, or SG-100B, conforming to the specifications in ASTM Designation: B 85, or the latest revision thereof. Material for permanent mold castings shall be aluminum alloy S-5A or CS-72A conforming to the requirements of and as listed in ASTM Designation: B 108.
- (b) Fabricated from corrosion resistant U.V. stabilized polycarbonate resin material. The moldings shall be a minimum of 0.090 inches thick and be ribbed for additional strength at point of high stress. Additional thickness shall be provided as necessary to eliminate light transmission through the housing, door, visor, or back plate. The housing of each section shall be a one piece, corrosion resistant, molding with integral sides, top and bottom, free of voids, cracks, inclusions, or blow holes.

722.14.1.1.2--Features. Each housing shall be furnished with provisions for mounting of a back plate. The top and bottom of the housing shall have an

opening two inches in diameter to accommodate standard 1½-inch pipe, with no other opening in the top or bottom of the housing. Individual signal sections shall be fastened together, one above the other into a complete signal face, by means of plated nuts, bolts and washers in such a manner that any section may be rotated about a vertical axis and positioned at an angle with respect to any adjacent section. The opening hub shall have 72 circumferential serrations to secure each section in its orientation, adjustable in five degree increments, and prevent its inadvertent rotation. A minimum six-position labeled barrier terminal block shall be provided in each signal face for the purpose of field connections. The barrier terminal shall be installed in the circular yellow or yellow arrow section of each signal face. If the face has both of these sections, the terminal block shall be installed in the circular yellow section. There shall be provisions for the attachment of a 3/16 inch tether line to the bottom of each span wire mounted signal head. A pinnacle shall be provided to close all 1½-inch holes in each housing which will not otherwise be sealed from the weather when installed with the specified mounting hardware.

722.14.1.2--Door. Each door shall be made of a material that is one of the above materials and which is compatible with the material of the housing, except that doors for plastic housings shall be plastic. The outer face of the door shall have four holes equally spaced about the circumference of the lens opening to accommodate the secure mounting of the signal head tunnel visor. The visor shall fit flush against the door and no light shall leak between the door and the visor. Two stainless steel hinge pins shall attach the door to the housing, one in the upper left corner and one in the lower left corner of the door. Two stainless steel wing screws, one in the upper right corner and one in the lower right corner of the door, shall be used for opening the door and closing it tight against the housing. The wing screws shall be installed through the door with keepers to prevent their accidental removal or falling out. The removal of the hinge pins and the operation of the wing screws shall not require the use of tools.

722.14.1.3--Optical System. The optical system shall consist of a lens, reflector and lamp socket. The system shall be designed to minimize sun phantom and eliminate light spill over. Prefocused incandescent lamps shall be the light source for all signals. The signals shall be equipped with and designed for 69 watt - 130 volt lamps with 2 7/16" LCL in eight-inch signals and 150 watt - 130 volt lamps with 3" LCL in 12-inch signals that conform to the latest Institute of Transportation Engineers standard on traffic signal lamps. All vehicle signal lenses shall be polycarbonate resin or acrylic and shall conform to the latest standards of the Institute of Transportation Engineers and American Standards Association optical specification. All reflectors shall be of ALZAK aluminum construction. The lamp socket shall be of bakelite construction, gasketed and be easily removable from the rear of the reflector for lamp replacement without the use of tools or the removal of the lens or reflector. The socket shall be fixed focus and permit its rotation a full 360 to orient bulb filament openings. The socket shall be securely held in the reflector so as not to loosen, rotate, or fall out

under vibration of traffic and wind movement of the signal head. The lamp socket shall be provided with two coded No. 18 AWG copper wire leads. The leads shall be fitted with insulated spade wire terminals and be of sufficient length to make field connections at the barrier terminal block. The vehicular signal lens, signal lamp socket and reflector shall form a sealed module that is not broken when the door is opened. The seal shall prevent moisture, dust, and road film contamination from entering the optical module and the signal housing.

722.14.1.4--Visors. Each signal door shall be fitted with a tunnel visor. Eight-inch signals shall have visors a minimum of seven inches long, 12-inch signals shall have visors a minimum of nine and one half inches long. The visor shall be flat black inside and Federal Yellow outside. The visors shall be attached to the door at four equally spaced locations with four placed screws or four bayonet-type self-locking tabs integrally formed with the visor. Visors for polycarbonate signal heads shall be made of a corrosion resistant polycarbonate resin at least 0.100 inch thick. Visors for metal signal heads shall be made from 0.064 inch minimum thickness aluminum alloy sheet.

722.14.1.5--Back Plate. Each signal head assembly, so required, shall be equipped with a back plate with a minimum width of five inches with radius corners. Steel rivets shall be provided for mounting to the signal housing. The back plate shall consist of one piece fabricated from corrosion resistant, flat polycarbonate resin material at least 0.125 inch thick or 0.064 inch minimum thickness aluminum alloy sheet.

722.14.1.6--Lenses. Traffic signal lenses shall be circular, red, yellow, or green in color, and eight-inch or 12-inch nominal diameter, as shown on the plans. No legend shall be permitted. Arrow lenses shall be circular, 12 inches in diameter, green or yellow in color, and be opaque except for the arrow legend. The lenses shall conform to all the applicable sections of the latest edition of ITE's Standard on Adjustable Face Vehicular Traffic Control Signal Heads.

722.14.1.7--Mounting Hardware. Span wire suspension fitting with cable entrance shall be a one-piece malleable iron casting, minimum wall thickness of 3/16 inch, and free of flash and voids. The cable entrance shall have a plastic bushing with a minimum inside diameter of one and one-quarter inch. The suspension fitting shall provide six separate, clevis pin positions for balancing the signal assembly. The thickness of the solid casting in this suspension area shall be a minimum of 5/8 inch. A hex head threaded malleable iron lock nipple shall be provided for attaching the signal head to the bottom of the suspension fitting for one face signals or to the top bracket of multiface signal brackets.

The mounting hardware for each signal face shall include a nylon, serrated, 72-tooth lock ring with full locking pins and a circular neoprene gasket for weather sealing.

Span wire suspension clamp assembly, consisting of a galvanized, malleable iron span wire clevis saddle, 5/8-inch diameter plated steel clevis pin with cotter key, two one-half inch plated steel "U" bolts with nuts and washers, no "J" bolts are permitted, and a galvanized malleable iron cable locking bar, all fitted for 3/8-inch guy span. Galvanizing is to meet ASTM Designation: A 153.

Brackets shall consist of a malleable iron center outlet body, schedule 40 pipe, elbows, serrated fittings, and other hardware as required to provide a multiface signal head assembly with internal wiring raceways to each face as specified.

Mounting brackets for mast arms shall conform to Subsection 722.11.

722.14.1.8--Color, Finish and Painting. Polycarbonate resin hardware shall have color impregnated throughout the material. The finish shall be smooth and unflawed. All metal hardware, except those specified as galvanized, plated, or stainless steel shall be painted with a primer coat and a finish coat of the best quality oven baked enamel. Lenses, reflectors, gaskets and polycarbonate parts shall not be painted. Signal head parts shall be colored as follows: Vehicle Head: Housing - federal yellow; Door - federal yellow; Tunnel Visor - flat black inside and yellow outside; Back Plate - flat black front and back; and Pole Bracket - federal yellow.

722.14.2-Traffic Signal Heads - Optically Programmed. Optically programmed traffic signal heads shall, in addition to the requirements prescribed in Subsection 722.14.1 above for conventional type, be so constructed, programmed, and operable, as to limit the visibility of the indication exclusively to the area where it is desirable that the indication be seen. This is to be accomplished with a built-in High Resolution Optical System designed for the purpose and is not to be accomplished by an arrangement of hoods, louver, or other external means.

722.14.3--Pedestrian Signal Heads - Conventional. Conventional pedestrian signal heads shall consist of all component materials necessary to form heads as specified on the plans and shall be complete with attachments for pole or post mounting. Heads shall conform to the applicable parts of the MUTCD.

Single section pedestrian heads shall be constructed of die cast aluminum. The housing shall be painted Federal Yellow. The housing and door shall be designed such that when properly assembled, they shall provide a waterproof and dustproof enclosure. All screws, bolts, hinge pins and other necessary fasteners shall be stainless steel.

An "egg crate" or "Z" crate type visor constructed of .030" minimum thickness, 100% impregnated black polycarbonate strips shall be provided with the signal head. The visor assembly shall be at least 1 1/2 inches deep and shall be bordered by a .040" minimum aluminum frame.

The design, manufacture and testing of lenses shall conform to the parts concerning "Traffic Signal Lenses" as set forth in "A Standard for Adjustable Face Traffic Control Signal Heads" as published by the Institute of Transportation Engineers. Individual letters of the legend shall be 4 1/2 inches high.

The reflector shall be a one piece reflector made of high temperature non-ferrous material or die-cast aluminum. The reflector shall consist of two parabolic curves, one behind the DON'T WALK legend and one behind the WALK legend. Construction shall be suitable to prevent any light from "leaking" from one legend to the other. Lamp sockets shall be designed to accommodate an A21, 67 watt lamp. Each socket shall be wired completely internally and ready for connection of field wiring. There shall be a minimum three position terminal block attached to the inside of the housing.

Prior to assembly, the housing and door frame shall be painted with one coat of primer and two coats of enamel. Color shall be Federal Yellow.

722.14.4--Pedestrian Signal Heads - Optically Programmed. Optically programmed pedestrian signal heads shall, in addition to the requirements prescribed in Subsection 722.14.3 above for conventional, be so constructed, programmed, and operable as to limit the visibility of the indication exclusively to the area where it is desirable that the indication be seen.

This is to be accomplished with a built-in High Resolution Optical System designed for the purpose and is not be accomplished by an arrangement of hoods, louvers or other external means.

722.14.5--Turn-Signal Sign. The turn-signal signs, as indicated on the plans, shall conform to the applicable requirements of Section 630.

722.14.6--Tether Cable. Tether cable attached to the bottom of the signal head shall conform to the requirements of Subsection 722.04 and of the size shown on the plans. Tether cable clamps shall be designed such that the clamp will break away without damage to the signal head when the tether cable is hit by a vehicle.

722.14.7--Back Plate. Back plates shall be supplied when called for on the plans. Back plates shall be one-piece construction and meet the requirements of Subsection 722.14.1.5.

722.14.8--Traffic Signal Lamps. Traffic signal lamps shall meet the requirements of the latest revision of the Institute of Transportation Engineers (ITE) "Standard for Traffic Signal Lamps". Sizes shall be as follows:

<u>Head</u>	<u>Wattage</u>	<u>Light Center Length (L.C.L.)</u>	<u>Average Rated Hours</u>
12" Traffic Signal	150 at 130 Volts	3 inch	8000
Pedestrian Signal	67 at 130 Volts	2 7/16 inch	8000

722.14.9--LED Signal Modules. LED signal modules shall be sealed units comprised of an outer lens, an optical lens, a printed circuit board for LEDs, and entirely enclosed power supply, a back cover and a gasket.

The assembly and manufacturing process for the LED signal modules shall be designed to assure all internal LED and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other sources as per MIL-STD-883.

The LED signal module shall be rated for use in the ambient operating temperature range of -40°C to +74°C.

The LED signal module lens shall be UV stabilized.

The light distribution of each LED shall be maximized by an internal beam controlling optical faceted lens designed and patented to meet the 44 points measurement of the VTCSH standard, Part 2. The outer cover made of ultraviolet stabilized polycarbonate shall be convex with a smooth outer surface and be an integral part of the module.

The chip in the ultra-bright 1/5 inch LEDs shall be made using AlInGaP for red and amber, and InGaN technology for the green, and be rated for 100,000 hours of continuous operation by the LED manufacturer.

Enclosures containing either the power supply or electronic components of the signal module shall be made of UL94VO flame retardant materials.

The measured chromaticity coordinates of LED signal modules shall conform to the chromaticity requirements of Section 8.04 and Figure 1 of the VTCSH standard. The LED manufacturers indicate the following X-Y coordinates for their respective LEDs. The X value for red LEDs varies from 0.690 to 0.708 and the Y value varies from 0.292 to 0.306. The value X for amber LEDs varies from 0.554 to 0.575 and the Y value varies from 0.424 to 0.445. The X value for the green LEDs varies from 0.1090 to 0.1138 and the Y value varies from 0.5673 to 0.5830.

All wiring and terminal blocks shall meet the requirements of Section 13.02 of the VTCSH standard. Two secured, color coded, three feet long 600 V, 20 AWG minimum, jacketed wires, conforming to the National Electrical Code, rated for service at +105°C, are to be provided for electrical connection.

The module shall operate on a 60 Hz AC line voltage ranging from 80 volts rms to 135 volts rms with less than 10% light intensity variation. Nominal rated voltage for all measurements shall be 120 ± 3 volts rms. The circuitry shall prevent flickering over this voltage range.

The individual LEDs be wired so that a catastrophic failure of one LED will result in the loss of only that one LED, and not the entire string of LEDs or the entire module.

The power supply must permit the regulation of the current supplied to the LEDs to maintain a constant current.

The LED signal and associated on-board circuitry must meet Federal Communications Commission (FCC) Title 47, Sub-Part B, Section 15 regulations concerning the emission of electronic noise.

The LED signal module shall provide a power factor of 0.90 or greater at 25°C and at the nominal operating voltage.

Total harmonic distortion (THD), current and voltage, induced into an ac power line by a signal module shall not exceed 20 percent, over the operating voltage range specified in Section 14 and within the ambient temperature range specified in Section 4.

The signal module on-board circuitry shall include voltage surge protection to withstand high-repetition noise transients and low-repetition high-energy transients as stated in Section 2.1.6, NEMA Standard TS-2, 1992.

The LED signal module shall operate from a 60 ± 3 Hz ac line power over a voltage range from 80 VAC rms to 135 VAC rms. The current draw shall be sufficient to ensure compatibility and proper triggering and operation of load current switches and conflict monitors in signal controller units the procuring traffic authority customer has in use. Load switches shall be compatible with NEMA TS-1 or later, or Model 170-1989 or later.

All LED signal modules shall be energized for a minimum of 24 hours, at 100 percent on-time duty cycle, in an ambient temperature of 60°C .

Each socket shall be provided with one black lead from the socket and one white lead from the shell. Terminal blocks shall be a six position, twelve block, terminal barrier strip placed in the top or red section of all traffic signal heads. Terminal blocks shall be secured on both ends.

722.15--Traffic Signal and Equipment Support Poles. Type V, VI, and VII shall be welded or seamless $4\frac{1}{2}$ -inch O.D. steel pipe, ASTM Designation: A 53, 36 ksi minimum yield strength, galvanized in accordance with ASTM

Designation: A 123.

722.16--Mast Arms for Traffic Signal and Equipment Poles. Mast arms shafts shall be tapered and fabricated from a single sheet of not less than No. 7 MSG hot rolled, commercial quality, carbon steel with a single longitudinal automatically electrically welded joint. The taper shall be approximately 14/100 inch per foot. After forming and welding, the tapered shaft shall be longitudinally cold rolled under sufficient pressure to flatten the weld and increase the physical characteristics of the shaft so that the metal will have a minimum yield strength of 55,000 psi. A flange plate of one and one-quarter inch thickness shall telescope the large end of the arm and be welded by two continuous electric arc welds, one being on the outside of the plate, adjacent to the shaft, and the other one on the inside at the end of the tubular cross section.

This flange plate shall have four holes for one and one-quarter high strength bolts which will match the four tapped holes in the mounting plate on the pole. Mast arms shall be galvanized in accordance with the requirements of ASTM Designation: A 123.

Poles for mast arms shall meet the same requirements as Type I poles and in addition, a flange plate of one and one-quarter thickness for supporting the mast arm shall be welded to the pole near the top and supported with side plates tangent to the pole and gusset plates both top and bottom.

722.17--Pedestrian Pushbutton. Pushbutton shall consist of a direct push type button and single momentary contact switch. The housing shall be cast metal and shall be primed and painted Federal Yellow in color. The housing shall be raintight and weatherproof and shall protect users from electrical shock. The pushbutton shall be provided complete with suitable mounting hardware for banding, or attaching by other suitable methods, to poles.

722.18.--Vehicle Loop Assemblies.

722.18.1--Vehicle Loop Sealant.

722.18.1.1--General. Material shall be a polyurethane or rubberized-asphalt system conforming to the requirements herein. The system shall be manufactured specifically for this use and shall be used in accordance with the manufacturer's instructions. The system shall be dielectric, have no detrimental effect on cable insulation, and bond to either Portland cement or bituminous concrete paving with minimal shrinkage. The material shall, when cured, retain flexible characteristics and accommodate movement associated with Portland cement and bituminous concrete pavements. The material shall not track in hot weather and be suitable for applying when the surface temperature is between 50°F and 130°F.

The material shall be resistant to the effects of weather, vehicular abrasion, motor oils, gasoline, antifreeze solution, brake fluid, and deicing chemicals normally encountered.

722.18.1.2--Polyurethane System. The polyurethane sealant shall be a one-part elastomeric compound requiring no mixing or application of heat prior to or during installation. The sealant shall meet the following additional requirements:

<u>Property</u>	<u>Requirement</u>	<u>Test Procedure</u>
Hardness, Shore A	85 maximum	ASTM: D 2240
Tensile Strength, psi	500 minimum	ASTM: D 412
Elongation, %	250 minimum	ASTM: D 412
Adhesion in Peel, pounds/inch	10 minimum	ASTM: D 903
Track-Free Time, Polyethylene Film, hours	24 maximum	-
Shelf Life, months	6 minimum	-

722.18.1.3-Rubberized-Asphalt System. Rubberized-asphalt sealant shall be a two-component, self-leveling, cold-applied liquid sealant with no heating or thinning. The two components shall be mixed in accordance with the manufacturer's instructions. The sealant shall conform to the following additional requirements:

<u>Property</u>	<u>Requirement</u>	<u>Test Procedure</u>
Pot Life @ 77°F, minutes	25 minimum	-
Initial Cure Time @ 77°F, hours	1.0 maximum	-
Hardness, Shore A	20 maximum	ASTM: D 2240
Flow @ 140°F, 5 hours	No Flow	ASTM: D 5329
Bond @ 0°F, 3 cycles, minimum	50% of original width	ASTM: D 5329
Water Absorption, 72 hours, %	0.1 maximum	-
ASTM #3 Oil, Absorption, 24 hours, %	0.1 maximum	-

722.18.1.4--Acceptance Procedure. The Contractor shall furnish to the Engineer three copies of the manufacturer's certification for each lot of sealant, stating that the sealant meets the requirements of these specifications.

722.18.2--Loop Wire. Loop wire shall meet the requirements of Subsection 722.03.

722.18.3--Conduit. Conduit required for installation of the loop lead-ins shall be in accordance with Section 668.

722.18.4--Probe Point Detection Units. When the loop assembly consists of probe point detection units, the probe units shall be capable of operating in a temperature range of -35°F to 165°F and in 100% humidity. The probe shall not

be affected by water, snow, ice or pavement deterioration. The probe cable shall be polyurethane jacketed, polypropylene insulated less than 1/4 inch in diameter. Probes are to be located in a one-inch vertical hole approximately 18 inches below the roadway surface. Probe cable is to be installed in 1/4-inch saw cut slot made by a diamond or abrasive power saw.

722.19--Loop Detector Amplifier Units.

722.19.1--General. These units shall be designed to operate on 115 volts, 60 Hz alternating current.

The unit shall be fully operable under voltage ranging from 100 to 134 volts and temperature ranging from -30°F to +165°F and shall not be affected by environmental conditions, altitude or positioning.

722.19.1.1--Stand Alone Units. The unit shall be of digital, solid state construction with printed circuit boards laminated from high quality glass-epoxy materials. Connections shall be made through a 10 pin MS type connector for the single channel and two channel units and a 19 pin MS connector for four channel units.

A dust resistant enclosure suitably protected against corrosion and accidental damage to field wiring shall be provided to enclose all electrical parts of the unit.

722.19.1.2--Card Rack Mounted Units. A card rack assembly shall consist of three main components, the card rack, power supply module(s) and loop detector amplifier module(s). A second power supply is required when more than four amplifier modules are required.

The card rack shall be manufactured from aluminum and designed to accommodate three through eight, two-inch wide modules. The card rack shall include universal mounting brackets for either side or rear wall or shelf mounting.

Each of the four outputs of the power module will power a plug-in magnetometer or digital loop detector module. Each output shall have a separate fuse and LED indicator light mounted on the front panel.

The loop detector amplifier module(s) shall be a digital, inductive loop detector amplifier with digital output timings.

722.19.2--Specific Requirements. The detector shall be capable of operating loop and lead-in systems with minimum composite inductance ranges from 50 to 1400 microhenries with maximum sensitivity capable of detecting 0.02 percent inductance changes.

722.19.3--Features and Operational Requirements. The unit shall have the following minimum features and operational requirements.

722.19.3.1--Fully Self-Tuning. The unit shall tune automatically upon the application of power. It shall achieve normal operation and at least 90% of its selected sensitivity within 30 seconds after application of power.

722.19.3.2--Modes of Operation. Each channel shall be capable of functioning in the following two front panel selectable modes:

- (a) Presence - When in this mode, the detector channel shall be capable of detecting the presence of a large motorcycle located in a conventional 6-foot x 6-foot, 3-turn loop, and holding the call for at least four minutes.
- (b) Pulse - A detection output between 75 and 150 milliseconds shall be initiated when a vehicle enters the zone of detection. If a vehicle remains in the zone of detection, the detector shall become responsive within a maximum of 30 seconds to additional vehicles entering the loop.

722.19.3.3--Sensitivity Switches. Each channel of the detector shall include means to select at least seven (7) levels of sensitivity up to a maximum sensitivity of at least 0.02 percent change in inductance.

722.19.3.4--Frequency Separation. The unit shall be capable of preventing cross-talk between channels of the same unit by sequential scanning of the various channels, and between separate units by means of a front panel mounted frequency control switch.

722.19.3.5--Output. Relay, N.O. and N.C. contacts. The relay shall furnish a continuous call in case of power failure, detector failure or an open loop.

722.19.3.6--Detection Indication. A long life LED or incandescent indicator shall be provided for each channel to give a visual indication of each vehicle detection.

722.19.3.7--Automatic Drift Compensation. The detector unit shall automatically accommodate those after-turning changes in the loop as might reasonably occur in undamaged loops, properly installed in sound pavement without producing a false output or change in sensitivity.

722.19.3.8--Detection of Continuous Traffic Queues. Each channel shall provide unlimited detection of continuous traffic without loss of detection in long peak-hour traffic queues. Vehicle movement over the loop shall re-start presence hold time.

722.19.3.9--Built-in Noise Rejection Circuitry. The detector electronics shall be adequately protected from transient voltages and currents which may occur on

both power lines and loop leads.

722.19.3.10--Write on Pads. A write on pad for each channel shall be provided on the front of the unit in order to label each channel.

722.19.3.11--Delay and Extension Timing. When called for in the plans, the detector shall contain the necessary electronics to provide both delayed call and extended call operation. Timing shall be digital and selection of delayed, extension or normal detector operation shall be accomplished via front panel control.

- (a) Delay timing shall inhibit detector output until presence has been maintained for the time selected. Each new detection shall restart the delay time. Timing adjustment shall be from 0 to 31 seconds in one-second increments. The detector shall be capable of disabling delay timing by external means during that detector's associated green phase. External input may be either ground active DC or line voltage AC active.
- (b) Extension timing shall hold detector output for the period of time selected after the vehicle leaves the loop. Timing adjustments shall be from 0 to 7.75 seconds in 0.25-second increments. The detector shall be capable of disabling extension timing by external means during that detector's associated red phase. External input may be the absence of either ground active DC or line voltage AC active.

722.19.3.12--Surge Protection. Each detector input circuit shall be equipped with a three terminal surge protection device capable of protecting the detector amplifier against differential mode surges and common mode surges. The unit must withstand six 400 Amp (8 x 20 μ s) differential mode surges and six 1000 Amp (8 x 20 μ s) common mode surges. The unit shall clamp these surges at 35 volts maximum in less than 40 nanoseconds. Differential capacitance shall be less than 50 picofarads. The unit shall be epoxy encapsulated.

722.20--Infrared Vehicle Detector Units. Infrared vehicle detector units shall operate on 115 volt A.C. or 24 volt D.C. current under temperature ranges of -40°F to 150°F.

Output shall be by fail safe, change over heavy duty relays, contacts rated at 60 VA, 2A, 250 V, or optically isolated solid state, with hold off voltage of 35 DC on voltage <1.5V at 50mA. Outputs shall be inhibited for one (1) second after detection has occurred.

Vehicle detection shall be indicated by illuminating a high intensity LED.

Units are to be capable of detecting moving vehicles within a zone of detection up to 300 feet from unit.

Units shall be housed in a weatherproof, dust-resistant enclosure for suitable side of pole mounting and appropriate adjustments for proper positioning. Positioning shall be accomplished by using a sighting hood placed on top of the housing.

The unit shall carry a minimum two-year manufacturer's warranty.

Surge protection required in the controller cabinet capable of protecting the controller cabinet from differential mode and common mode surges.

722.21--Fiber Optic Cable.

722.21.1--Fiber Characteristics. All fibers in the cable must be usable fibers and meet required specifications.

Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding. The fiber shall be matched clad design.

MULTIMODE: The multimode fiber utilized in the cable specified herein shall meet EIA/TIA-492AAAA-1989, "Detail Specification for 62.5 μm Core Diameter/125 μm Cladding Diameter Class Ia Multimode, Graded Index Optical Waveguide Fibers."

Core diameter:	62.5 $\pm$ 3.0 μm
Cladding diameter:	125.0 $\pm$ 2.0 μm
Core-to-Cladding	Offset: 3.0 μm
Cladding non-circularity:	2.0% Defined as: $[1 - (\text{min. cladding dia.} \div \text{max. cladding dia.})] \times 100$
Core non-circularity:	5.0% Defined as: $[1 - (\text{min. core dia.} \div \text{max. core dia.})] \times 100$
Coating Diameter:	245 $\pm$ 10 μm
Colored Fiber Diameter:	nominal 250 μm
Attenuation Uniformity:	No point discontinuity greater than 0.20 dB at either 850 nm or 1300 nm
Refractive Index Profile:	Graded index
Numerical Aperture:	0.275 $\pm$ 0.015

SINGLE-MODE: The single-mode fiber utilized in the cable specified herein shall conform to the following specifications:

Typical Core Diameter:	8.3 μm
Cladding Diameter:	125.0 $\pm$ 1.0 μm
Core-to-Cladding Offset:	0.8 m
Cladding Non-Circularity:	1.0%

	Defined as: $[1 - (\text{min. cladding dia.} \div \text{max. cladding dia.})] \times 100$
Coating Diameter:	245 ±10 µm
Colored Fiber Diameter:	nominal 250 µm
Attenuation Uniformity:	No point discontinuity greater than 0.10 dB at either 1310 nm or 1550 nm
Attenuation at the Water Peak:	The attenuation at 1383 ±3 nm shall not exceed 2.1 dB/km
Cutoff Wavelength:	The cabled fiber cutoff wavelength (λ_{ccf}) shall be < 1250 nm
Mode-Field Diameter:	9.30 ±0.50µm at 1310 nm 10.50 ±1.00 µm at 1550 nm
Zero Dispersion Wavelength (λ_0):	1301.5 nm $\pm$ 1321.5 nm
Zero Dispersion Slope (S_0):	0.092 ps/(nm ² km)
Polarization Mode Dispersion:	0.5 ps/rt ² km

The coating shall be a dual-layered, LTV-cured acrylate applied by the fiber manufacturer.

The coating shall be mechanically strippable without damaging the fiber.

722.21.2--Fiber Specification Parameters. The Maximum Individual Fiber Attenuation for multimode fibers shall be 3.5dB/km @ 850 nm, 1.0 dB/km @ 1300 nm. The Maximum Individual Fiber Attenuation for single-mode fibers shall be 0.40dB/km @ 1310 nm, 0.30 dB/km @ 1550 nm.

For multimode use, the minimum normalized bandwidth of multimode optical fibers shall be 160 MHz_km at 850 nm and 500 MHz_km at 1300 nm.

For single-mode use, the maximum dispersion shall be 3.2 ps/(nm_km) from 1285 nm through 1330 nm and shall be 17 ps/(nm_km) at 1550 nm.

722.21.3--Outdoor Trunk Cables. Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be 1/8 inch. Each buffer tube shall contain up to 12 fibers. The fibers shall not adhere to the inside of the buffer tube.

Each fiber shall be distinguishable from others by means of color coding in accordance with EIA/TIA-598-A, "Optical Fiber Cable Color Coding". The ink for coloring fibers shall be UV cured, no thermal inks shall be used in the coloring process. Buffer tubes containing fibers shall also be color coded with distinct and recognizable colors in accordance with EIA/TIA-598, "Optical Fiber Cable Color Coding". Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be one mm.

For dual layer buffer tube construction cables, standard colors are used for tubes 1 through 12 and stripes are used to denote tubes 13 through 24. The color sequence applies to tubes containing fibers only, and shall begin with the first tube. If fillers are required, they shall be placed in the inner layer of the cable. The tube color sequence shall start from the inside layer and progress outward.

In buffer tubes containing multiple fibers, the colors shall be stable during temperature cycling and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.

The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrinkback requirements of 7 CFR 1755.900.

Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.

The central anti-buckling member shall consist of a glass reinforced plastic rod. The purpose of the central member is to prevent buckling of the cable.

Each buffer tube shall be filled with a non-hygrosopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional nontoxic solvents.

Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "SZ", stranding process. Water blocking yarn(s) shall be applied longitudinally along the central member during stranding.

For single layer cables, a water blocking tape shall be applied longitudinally around the outside of the stranded tubes/fillers. The tape shall be held in place by a single polyester binder yam. The water blocking tape shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt and foreign matter. Dual layer cables shall be water blocked in a similar fashion.

Two polyester yam binders shall be applied contrahelically with sufficient tension to secure the buffer tube layer to the central member without crushing the buffer tubes. The binders shall be non-hygrosopic, non-wicking and dielectric with low shrinkage.

The cable shall contain at least one ripcord under the sheath for easy sheath removal.

Tensile strength shall be provided by high tensile strength aramid yams and/or fiberglass yams.

The high tensile strength aramid yams and/or fiberglass yams shall be helically stranded evenly around the cable core.

The cable shall be sheathed with medium density polyethylene. The minimum nominal jacket thickness shall be 0.055 inch. Jacketing material shall be applied directly over the tensile strength members and water blocking tape. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

The jacket or sheath shall be free of holes, splits, and blisters. The cable jacket shall contain no metal elements and shall be of a consistent thickness. The cable jacket shall be marked with "Manufacturer's Optical Cable" sequential foot markings, year of manufacture. The actual length of the cable shall be within -0/+1% of the length markings. The marking shall be in contrasting color to the cable jacket. The height of the marking shall be approximately 0.10 inch.

The maximum pulling tension shall be 608 lbf during installation, short term, and 200 lbf long term installed.

The shipping, storage, and operating temperature range of the cable shall be -40°F to +160°F. The installation temperature range of the cable shall be -20°F to +160°F.

722.21.4--Drop Cable to Controllers, VMS, Camera Locations. Optical fibers shall be placed inside a single loose buffer tube. The buffer tube shall contain up to 12 fibers. The fibers shall not adhere to the inside of the buffer tube. Each fiber shall be distinguishable from others.

The colors shall be stable during temperature cycling and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.

The buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional nontoxic solvents.

The cable core interstices shall be filled with a water-blocking compound or water blocking strength members. The compound, if used in the design shall be a thixotropic gel containing a Super Absorbent Polymer (SAP) material. The gel shall be non-nutritive to fungus, electrically non-conductive and homogenous. The gel shall be free from dirt and foreign matter and shall be readily removable with conventional nontoxic solvents.

The cable shall contain at least one ripcord under the sheath for easy sheath removal. Tensile strength shall be provided by high tensile strength yams. The

high tensile strength yarns shall be helically stranded evenly around the central tube.

The cable shall be sheathed with UV resistant jacketing compound. The minimum nominal jacket thickness shall be 0.055 inch. Jacketing material shall be applied directly over the tensile strength members and water blocking compound. The jacketing material shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus. The jacket or sheath shall be free of holes, splits, and blisters.

The cable jacket shall contain no metal elements and shall be of a consistent thickness. The maximum diameter of the cable shall not exceed 0.39 inch. The cable jacket shall be marked with "'Manufacturer' Optical Cable", sequential foot markings, year of manufacture. The actual length of the cable shall be within -0/+1% of the length markings. The marking shall be in contrasting color to the cable jacket. The height of the marking shall be approximately 0.10 inch.

The maximum pulling tension shall be a minimum of 300 lbf during installation, short term, and 115 lbf long term installed.

The shipping, storage, and operating temperature range of the cable shall be -40°F to +160°F. The installation temperature range of the cable shall be -20°F to +160°F.

722.21.5--General Cable Performance Specifications for OSP Cables. When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fiber, Optical Cable, and Other Passive Fiber Optic Components", the change in attenuation at extreme operational temperatures of -40°F to +160°F shall not exceed 0.2 dB/km at 1550 nm for single-mode fiber and 0.5dB/km at 1300 nm for multimode fiber.

When tested in accordance with FOTP-82, "Fluid Penetration Test for Filled Fiber Optic Cable", a one-meter length of unaged cable shall withstand a one meter static head or equivalent continuous pressure of water for one hour without leakage through the open cable end.

When tested in accordance with FOTP-81, "Compound Flow (Drip) Test for Filled Fiber Optic Cable", the cable shall exhibit no flow (drip or leak) of filling or flooding compound at 150°F.

When tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables", the cable shall withstand a minimum compressive load of 125 lbf/in applied uniformly over the length of sample. The load shall be applied at the rate of 1/8 inch to 3/4 inch per minute and maintained for 10 minutes. The change in attenuation shall not exceed 0.4 dB during loading and 0.2 dB after loading at 1550 nm for single-mode fiber and 1.0 dB during loading and 0.4 dB

after loading at 1300 nm for multimode fiber.

When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test", the cable shall withstand 25 mechanical flexing cycles around a sheave diameter not greater than 20 times the cable diameter. The change in attenuation shall not exceed 0.1 dB at 1550 nm for single-mode fiber and 0.3 dB at 1300 nm for multimode fiber.

When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," the cable shall withstand 25 impact cycles. The change in attenuation shall not exceed 0.2 dB at 1550 nm for single-mode fiber and 0.3 dB at 1300 nm for multimode fiber.

When tested in accordance with FOTP-33, "Fiber Optic Cable Tensile Loading and Bending Test", using a maximum mandrel and sheave diameter of 22 inches, the cable shall withstand a tensile load of 608 lbf. The change in attenuation shall not exceed 0.2 dB during loading and 0.1 dB after loading at 1550 nm for single-mode fiber and 0.5 dB during loading and 0.2 dB after loading at 1300 nm for multimode fiber.

When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test", a length of cable no greater than 12.5 feet will withstand 10 cycles of mechanical twisting. The change in attenuation shall not exceed 0.1 dB at 1550 nm for single-mode fiber and 0.2 dB at 1300 nm for multimode fiber.

When tested in accordance with FOTP-37, "Low or High Temperature Bend Test for Fiber Optic Cable", the cable shall withstand four full turns around a mandrel of 10 times the cable diameter after conditioning for four hours at test temperatures of -20°F and +140°F. Neither the inner or outer surfaces of the jacket shall exhibit visible cracks, splits, tears or other openings. Optical continuity shall be maintained throughout the test.

722.21.6--Quality Assurance Provisions. All optical fibers shall be proof tested by the fiber manufacturer at a minimum load of 100 kpsi. All optical fibers >3000 feet shall be 100% attenuation tested. The attenuation of each fiber at both operational windows shall be provided with each cable reel. The cable manufacturer shall be ISO 9001 registered.

722.21.7--Packaging. The completed cable shall be packaged for shipment on nonreturnable wooden reels. Top and bottom ends of the cable shall be available for testing. Both ends of the cable shall be sealed to prevent the ingress of moisture. Each reel shall have a weather proof reel tag attached identifying the reel and cable.

722.22--Multi-Channel Video Multiplexer.

722.22.1--Features. The multi-channel video multiplexer shall have the following features.

- 8-Bit Digitally-Encoded Video Transmission Transmits up to 16 Real-Time Color Video Signals on One Optical Fiber.
- Meet or exceed all requirements for RS-250C Medium Hall Transmission.
- Exceptionally Low Video Distortion with Zero Performance Variation vs. Optical Path Loss.
- Ideally Suited to Networks Requiring Multiple Physical Layers Where Video Degradation May be a Problem.
- Be directly Compatible with All NTSC, PAL, or SECAM CCTV Camera Systems.
- Wide Optical Dynamic Range.
- Meet or exceed NEMA TS-1/TS-2 and Caltrans Traffic Signal Control Equipment Environmental Specifications for Operating temperature, Shock, Vibration, Humidity and Voltage Transient Protection.
- Ensure Extremely High Reliability in Unconditioned Out-of-Plant Environments.
- Provide LED Status Indicators.
- Provide Solid-State Current Limiters.
- Lifetime Warranty.

722.22.2--Specifications. The multi-channel video multiplexer shall have the following specification requirements.

VIDEO

Video Input	1 volt peak to peak @ 75 ohms
Input and Output Channels	4, 8, 12 or 16
Bandwidth	5 Hz to 6.5 MHz
Differential Gain	<2%
Differential Phase	<0.7%
Tilt	<1%
Signal-to-Noise Ratio (SNR)	60 dB @ Maximum Optical Loss Budget

ELECTRICAL & MECHANICAL

Power	115-230 VAC, 50/60 Hz, 10 Watts
Current Protection	Automatic Resettable Solid-State Current Limiters
Circuit Board	Meets IPC Standard

ENVIRONMENTAL

MTBF	>100,000 hours
Operating Temp	-40° C to +74° C
Storage Temp	-40° C to +85° C
Relative Humidity	0% to 95%, non-condensing

OPTICAL EMITTER:	Laser Diode
WAVELENGTH:	1300/1550 nm
NUMBER OF FIBERS:	1

LED INDICATIONS

Multiplexer Unit:

- 1. Video Input Sync Presence for Each Video Channel
- 2. Operating Power

Demultiplexer Unit:

- 1. Video Output Sync Presence for Each Video Channel
- 2. Optical Carrier Detect/Link-Lock
- 3. Operating Power
- 4. Video Sync Presence for Each Channel

**SECTION 723 - MATERIALS FOR ROADWAY LIGHTING
INSTALLATION**

723.01--General. Acceptance of all material in this Section is subject to Subsections 106.01 and 106.04 entitled "Source of Supply and Quality Requirements" and "Certification of Compliance", respectively.

723.02--Secondary Distribution.

723.02.1--Raceways, Conduit and Fittings. All branch circuits shall be in Schedule 40 polyvinyl chloride (PVC) or high-density polyethylene (HDPE) conduit unless specifically shown or noted otherwise on the plans, or stated otherwise in these specifications. Conduit exposed on service poles and within five (5) feet of any pole foundation or terminating point shall be galvanized rigid (GRC) heavy wall conduit.

Under roadways, or where conduit is jacked or bored, use Schedule 80 PVC or HDPE conduit.

When transitioning between differing types of conduit, the correct coupling must be used; i.e. GRC to PVC, PVC to HDPE, etc. These couplings shall be approved prior to their use on the project.

In outdoor structure mounted exposed locations, except as noted on the plans, galvanized or sherardized rigid steel conduit shall be used.

At underground entrance or exit locations, all rigid metal conduits in contact with earth shall be polyvinyl, polyethylene, or asphalt paint coated with three (3) coats, unless shown otherwise on the plans.

723.02.2--Conductors. Conductors shall be standard annealed copper rated 600 volts with mechanical strength, insulation, and current carrying capacity adequate for the particular conditions under which they are used and in accordance with the following schedule:

In all locations, types "THW" or "THWN" shall be used unless indicated otherwise on the plans and/or in the specifications.

In unwired fixtures where required by National Electrical Code (NEC), approved heat resistant wire shall be used. This wire shall be sized for current, voltage, and temperature at which fixture operates and in accordance with the latest edition of the NEC.

All conductors entering the self-contained ballast compartment of gaseous vapor discharge fixtures shall be rated 600 volts, silicone rubber, fixture wire, #10 AWG, stranded copper conductor, silicone rubber insulation, glass braid, rated conductor temperature of 200°C.

Wire sized #8 AWG and larger consisting of the stranded type shall have Class B stranding. Wire sized #10 AWG and smaller shall be of the solid type.

The minimum wire size allowed on any project, with exceptions as noted on the plans or as stated in the specifications, will be #12 AWG.

723.02.3--Pull Boxes and Junction Boxes. Pull boxes shall be of the types specified on the plans. The number and location of pull boxes shall comply with the requirements of the NEC. Pull boxes shall be used to limit the strain while pulling conductors and splices will not be allowed.

Junction boxes will of the type specified on the plans. Splices will be allowed in junction boxes. Junction boxes shall comply with the applicable requirements of the NEC. All items required by codes, such as grounds, ground rods, etc., shall be supplied and installed as part of the box and will be included as part of the cost of the box.

Ground mounted boxes shall have tops that are reinforced and rated H-20 for vehicular traffic.

Where shown on the plans a concrete collar or pad shall be constructed around the box. The dimensions of the concrete shall be specified in the plans. When the box falls on a slope it, and the pad, will be constructed to conform to the

contours of the slope. Site grading and other items will be included in the cost of the box.

723.03--Secondary Power Controller.

723.03.1--Lighting Controller. The lighting controller shall be factory assembled and contain the following items: one contactor, one hand-off-automatic selector switch, fused control circuit transformer, lightning arrestor, branch circuit breakers, a NEMA 3R enclosure, one photoelectric control and a main breaker. Details and schedules are shown on the plans. All breakers shall be labeled as to circuit served with a phenolic engraved label having 1/4-inch white letters on a black background.

723.03.1.1--Contactor. The contactor shall have a continuously rated 120-volt coil which is encapsulated. The contactor shall switch a load at 480 volts and shall have a minimum of 2 poles rated as per the plans. Auxiliary arcing contacts are not permitted. Power contacts shall be totally enclosed and of silver-cadmium-oxide. The contactor shall be in accordance with U.L. 508 and NEMA ICS 2, and rated for 600 volts maximum.

723.03.1.2--Main Breaker. The main breaker shall be a molded case circuit breaker rated at the amperage shown on the plans. Interrupting ratings shall be 22,000 amperes R.M.S. symmetrical. The breaker shall have an over-center trip-free toggle type operating mechanism with quick-make, quick-break action and the switch is "ON" "OFF". The breaker handle shall assume a center position when tripped, with a provision for mechanically tripping the breaker built into the cover. The breaker shall be calibrated for operation at 40°C.

723.03.1.3--Hand-Off-Automatic Selector Switch. The H-O-A switch shall be a heavy duty, three position, maintained contact selector switch with ratings as follows:

7200 VA make
720 VA break
120 - 600 V.A.C.

723.03.1.4--Control Transformer. Control transformer shall have a 480 volt primary and 120 volt secondary, with a fused secondary. The volt-ampere rating shall be a minimum of 500 VA above contactor requirements for other loads.

723.03.1.5--Lightning Arrestor. Arrestor shall be a low impulse spark over and high discharge - current capacity type.

723.03.1.6--Branch Circuit Breakers. Branch circuit breakers shall be molded case breakers, U.L. listed and shall meet NEMA Standard No. ABI-1975, and Federal Specification No. W-C-375B/GEN. The amperage ratings shall be as

scheduled on the plans. Interrupting ratings shall be 22,000 amps RMS symmetrical.

Breakers shall have over-center, trip-free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle indication. All 2-pole breakers shall be common trip. Each breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole. Circuit breaker handles shall assume a center position when tripped, with a provision for mechanically tripping the breaker built into the cover. Breakers shall be calibrated for operation in an ambient temperature of 40°C.

Breaker lugs shall be removable U.L. listed for copper only, and U.L. listed for installation of mechanical screw type lugs.

723.03.1.7--Copper Busing. Busing shall be copper with tin plating. Rating shall be 100 ampere or 200 ampere as scheduled on the plans.

723.03.1.8--Enclosure. The enclosure shall be NEMA 3R of minimum #14 gauge steel with a hinged door. One (1) hasp with padlock and a minimum of two (2) bolts to secure top and bottom of door shall be provided. Three (3) sets of keys shall be provided with each padlock.

723.03.2--Conduit. All conduit and fittings shall be rigid galvanized steel, sized as per plans or NEC.

723.03.3--Ground Rods. All ground rods shall be copper-coated steel 3/4-in by 10 feet installed as shown on plans. Ground wire connections shall be with exothermic welds.

723.03.4--Photocells. Photocell shall have a dust and watertight housing, and shall be rated for 120 volt operation. Contacts shall be rated at 1800 V.A. A time delay of a minimum of 15 seconds shall be built-in to prevent false switching. Turn-on shall be at approximately 1 to 3 foot-candles. Turn-off shall be at 1.5 to 9 foot-candles. Operational temperature range shall be -50 to +60°C. Failsafe protection is required in the closed position.

Mounting shall be as per plans. Built-in surge protection shall provide a margin of protection of 60°C spark over -1500 V RMS. Impulse spark over voltage discharge is 10,000 amperes, 1½ x 40 M.S. wave at 2000 volts.

Where required on plans that a photocell control Federal Aviation Administration (FAA) obstruction lights that photocell shall meet current FAA requirements.

723.03.5--Miscellaneous Hardware. All miscellaneous hardware shall be galvanized per ASTM Designation: A123.

Care shall be taken to reduce corrosion as much as possible. After drilling or cutting of parts or any operation that may damage anti-corrosion paint or coatings, the Contractor shall clean and apply anti-corrosion paint or coating. This shall be done at no additional cost to the Department.

723.03.6--Service Poles. Service poles shall be Southern Yellow Pine meeting the requirements of the latest edition of ANSI-05.1, "American National Standard for Wood Poles - Specifications and Dimensions", for Southern pine poles having a fiber stress of 8,000 psi. The poles shall be free of all defects such as holes, splits, sap rot, etc. Maximum deviation from straight poles shall be 1/2 inch for each six foot of length from surface of ground to top of pole when a string is stretched along its bow. Poles shall be approximately thirty (30) feet in length.

All poles shall be inspected and treated in accordance with applicable requirements of the American Wood-Preservers' Association (AWPA) and shall conform to Subsection 718.03 of the Standard Specifications.

723.03.7--Wiring. Wiring shall be copper conductors with THWN or THW type insulation. All wiring shall be tie wrapped and neatly trained in the enclosure.

723.04--High Mast Lighting Assembly.

723.04.1--Pole. The pole shall consist of sections of round or multi-sided tapered steel tubes which telescope together. Minimum yield strength after fabrication shall be 55,000 psi. Designed wind velocity shall be 100 MPH with a 1.3 gust factor to support the number and type luminaires and lowering device required on the different assembly types.

The pole shall be of ASTM Designation: A 572 or A 595, Grade 60 steel, hot dipped galvanized in accordance with ASTM Designation: A 123.

All factory welds shall be in accordance with ANSI/AWS Structural Welding Code D1.1 sections 1-8, and AASHTO requirements.

The pole shall have a minimum 10-inch wide by 20-in high oval handhole. The opening shall be reinforced to replace the equivalent strength lost by the hole. A hinged and gasketed handhole cover shall be provided, secured by four (4) stainless steel bolts, with three (3) hinges having stainless steel hinge pins. The cover shall be lockable with a hasp and a padlock provided and installed on each cover. The padlocks shall be keyed the same as the controller enclosures.

723.04.2--Lowering Device.

723.04.2.1--General. The lowering device shall be capable of lowering the luminaires to approximately five (5) feet from ground level for maintenance purposes. The lowering device shall consist of the following assemblies:

- (1) Head frame assembly
- (2) Luminaire mounting ring assembly
- (3) Winch assembly
- (4) Hoisting cable assembly

723.04.2.2--Head Frame Assembly. The head frame assembly shall be galvanized steel with a weather tight spun aluminum cover. A roller or pulley assembly shall be provided for power cord travel.

Three (3) positive latches shall be provided to support the luminaire ring when the lowering device is not in operation. Reflecting flags, visible from the ground, shall indicate the locking and unlocking of each of the latches. All moving parts of the latches shall be serviceable from the ground. Moving parts shall not be impaired by formation of ice. Latches shall be cast aluminum alloy conforming to ASTM Designations: B 221 or A 36 steel. Latch pins shall be ASTM A 276 stainless steel.

723.04.2.3--Luminaire Mounting Ring Assembly. The ring assembly shall be hot dipped galvanized steel channel, typically 6-inch by 2-inch, 7-gauge, with the proper number of 2-inch galvanized steel pipe luminaire mounting arms. The ring assembly shall be prewired with type ST distribution wiring, insulation rated at minimum 105°C. A cast aluminum or stainless steel, hinged cover, weather tight junction box shall be provided with a prewired 600-volt terminal block and a weatherproof twist lock power inlet, for testing of luminaires at ground level. This box shall be aligned with the access handhole cover.

The ring assembly shall be equipped with roller contact spring loaded guide arms to stabilize the ring on the pole while lowering device is in operation.

723.04.2.4--Winch Assembly. The winch shall be rated for 1500 pounds with a worm gear reduction minimum 30 to 1 ratio, and an integral friction drag brake to prevent free spooling. The winch shall be rated for intermittent motor operation or for hand crank operation. The 1/4-inch stainless steel hoisting cable shall be prewound on the winch. The winch drum shall be secured at both ends to prevent tilting.

723.04.2.5--Hoisting Cable Assembly. The hoisting cable shall be minimum 1/4-inch, 7 x 19 stainless steel. The three (3) suspension cables shall be minimum 3/16-inch stainless steel. The cable terminator shall be hot dipped galvanized.

Power cable shall be type SO and of a length and size as shown on plans.

723.04.3--Luminaire.

723.04.3.1--General. The luminaire shall be of the type and size as shown on the plans, normally an enclosed ventilated type with a one piece spun specular aluminum reflector, finished with an alzak or equivalent process. The reflector shall be encased in a spun and sealed aluminum cover or ribbed to provide additional structural integrity.

723.04.3.2--Ballast. The ballast shall be enclosed in a cast aluminum weather tight housing. Connections shall be made through a quick disconnect plug. The ballast shall be fused with inline fuses sized as per manufacturer's recommendations. The ballast shall be copper wound.

Electrical characteristics shall closely conform to the following:

Ballast Type	Lead
Primary Voltage	480V
Secondary Voltage (open circuit)	400V
Power Factor	over 90%
Input Watts	1100
Wattage Regulation	±12% at 10% line volt variation
Minimum Ambient Starting Temperature	20°F
Operating Line Current	2.35A

723.04.3.3--Mounting. The mounting shall be with an adjustable slipfitter for a 2-inch pipe bracket.

723.04.3.4--Lamp Socket. The lamp socket shall be heavy-duty, nickel-plated, porcelain enclosed with an integral lamp gripper and a lamp clamp of insulated stainless steel.

723.04.3.5--Photometrics. The luminaire shall provide an Illuminating Engineering Society (IES) Type V semi-cutoff distribution or as shown on the plans and shall have an output efficiency of 60% bare lamp lumens.

The lamp arc tube shall be optically shielded above 52° from the nadir. The maximum beam candle power for each 1000 lumens shall be a maximum of 200 at 80° vertical

Test reports with illumination data for each type distribution shall be provided with luminaire submittals. These reports must be certified, or conducted by an independent testing laboratory.

723.04.4--Anchor Bolts. Anchor bolts shall be steel in accordance with ASTM Designation: F 1554, Grade 105. Minimum yield strength shall be 105,000 psi. Galvanizing shall be in accordance with ASTM Designation: A 153. Anchor

bolts shall be of the sizes and number recommended and provided by the pole manufacturer.

Each pole shall have a bolt layout template provided by the pole manufacturer for proper bolt installation. The Contractor shall align the template properly for correct handhole orientation.

723.04.5--Lamps. Lamps for high mast luminaires shall be universal burning 1000-watt high pressure sodium. The lamp shall be mogul base and T-18 bulb designation. The lamp shall meet or exceed the following criteria:

Mean Lumens -----	126,000
Initial Lumens -----	140,000
Rated Average Life at 10 hr/start, hours -----	24,000

723.04.6--Miscellaneous. Ground rods shall be 3/4-inch by ten (10) feet, copper coated steel. Lightning rods, cable, bolts and other items making up the high mast lighting assembly shall be provided as per the plans and manufacturer's recommendations. All incidental items necessary for a complete working system shall be provided whether or not mentioned in these specifications.

723.05--Low Mast Lighting Assembly.

723.05.1--Poles. Poles shall be formed from a single sheet of hot rolled weldable grade steel, galvanized in accordance with ASTM Designation: A 123. Unless otherwise specified in the plans, the poles shall be forty (40) feet in length.

Unless otherwise noted on the plans, poles shall be made from steel meeting the requirements of ASTM Designation: A 572 Grade 55, or A 595 Grade A. Minimum yield strength shall be 48,000 psi after fabrication. Design wind loading shall be as indicated on the plans. The pole shall meet design wind loading with luminaires installed.

Poles shall have a mast arm as required and specified on the plans for luminaire mast arm mounting. Post top mounted luminaires will require a tenon mount.

Poles shall have a constant taper of 0.14 inch nominal per foot.

All poles shall be equipped with a breakaway device which conforms to the latest AASHTO and FHWA requirements, which have been approved by same. The Contractor shall submit a manufacturer's certification with the pole shop plans stating that the device meets, or exceeds, these standards.

Bridge-mounted poles shall be equipped with standard anchor bases for mounting on bridge brackets.

Poles shall have a 4-inch by 6½-inch handhole with bolted cover.

Arm lengths shall be as specified on the plans.

723.05.2--Luminaire. Low mast luminaires shall be post top mounted or mast arm mounted with 150-watt, 250-watt or 400 watt high pressure sodium lamps or as required on the plans.

The housing shall be die cast aluminum, joined with a lower housing by a stainless steel hinge, and provided with a trigger latch. The finish shall be gray baked-on enamel.

The reflector shall be polished anodic surface aluminum. The refractor shall be prismatic borosilicate glass. Photometrics shall conform to IES Type III, medium, semi-cutoff or as shown on the plans. Seals and gaskets shall be provided to prevent the entry of contaminants.

The ballast shall be prewired and closely conform to the following criteria:

	<u>400-watt</u>	<u>250-watt</u>	<u>150-watt</u>
Primary Voltage	480 V	480 V	480 V
Operating Current	1.0 A	0.63 A	0.42 A
Secondary Voltage, open circuit	215 V	222 V	128 V
Input Watts	458 W	295 W	188 W
Power Factor	Over 95%	Over 95%	Over 95%
Lamp Wattage Regulation @ ±10% Line Voltage Variation	+10%		
Minimum Ambient Starting Temperature	-20°F		

The ballast shall also have a quick disconnect. The slipfitter shall accept 1¼ to 2-inch outer diameter arms. Maximum projected area shall be 1.5 square feet.

723.05.3--Anchor Bolts. Anchor bolts shall be made of steel in accordance with ASTM Designation: F 1554, Grade 55. Anchor bolts shall be galvanized as per ASTM Designation: A 123. Minimum yield strength shall be 50,000 psi and "L" shaped. Anchor bolts shall be provided for each pole with two (2) hex nuts and washers per bolt. A bolt layout template shall be provided by the manufacturer for proper bolt installation. The number of anchor bolts and design yield strength shall be as recommended by the manufacturer.

723.05.4--Lamps. Lamps shall be clear 150-watt, 250-watt or 400-watt high pressure sodium type, which operate in any position. The lamps shall conform to the following:

	<u>150-watt</u>	<u>250-watt</u>	<u>400-watt</u>
Mean Lumens	14,000	27,500	45,000
Initial Lumens	16,000	24,750	50,000
Average Rated Life, hours	24,000	24,000	24,000

723.05.5--Miscellaneous. Wiring, ground rods, bolts and other items shall be provided as per the plans and manufacturer's recommendations. All items necessary for a complete working lighting assembly shall be provided whether or not mentioned in these specifications. Ground rods shall be 3/4-inch by ten (10) feet copper coated steel.

723.06--Underpass Lighting Assembly.

723.06.1--Housing. The lens shall be injection molded, U.V. stabilized polycarbonate. The reflector shall consist of a hydroformed specular alzak main reflector with parabolic and cylindrical surfaces. The unit shall produce a lighting pattern with a sharp cutoff at 86° above nadir.

Photometrics shall be IES, Type III, or as shown on the plans.

723.06.2--Ballast. The ballast shall be a high power factor type CWAA for 30°C starting and for a 150-watt, high pressure sodium lamp at 480 volts with double fusing.

723.06.3--Conduit Box. The conduit box shall consist of cast aluminum housing with gasketing, bolted to a flat aluminum plate.

723.06.4--Finish. The finish shall be a gray polyester powder coating which has been electrostatically applied and oven cured.

723.07--Portable Electric Power Unit.

723.07.1--General. The unit shall drive the winch through a torque limiter coupling to prevent excessive force on the system. A back-up shear pin shall be provided set for fifty six (56) pounds maximum. The unit used by the Contractor during construction will not be accepted. The power unit provided to the Department shall be new and unused except for testing to assure proper operation.

723.07.2--Housing. The housing shall be of cast aluminum.

723.07.3--Motor. The motor shall be heavy duty with high temperature windings. The rotor shall be dynamically balanced to assure vibration free operation. The motor shall operate at 120 volts AC, 60 hertz, with the proper horsepower to operate the lowering device recommended by the manufacturer.

723.07.4--Portable Transformer. The transformer shall be rated 480 volts primary and 120 volts secondary, rated KVA shall be 1.5 times necessary for the operation of the lowering device. The primary shall have a male weatherproof receptacle for acceptance of the pole power cord plug. The secondary shall have a weatherproof duplex receptacle, one (1) for connection of the power unit, and one (1) for other tools.

723.07.5--Remote Control Unit. The remote control unit shall have twenty (20) feet of remote cord, with a FORWARD, OFF, REVERSE switch. The switch operation shall be maintained contact type. Momentary contact spring load operation is not acceptable.

723.08--Temporary Lighting System.

723.08.1--Instructions. All exposed conduit shall be rigid galvanized steel. RTV silicon shall be used on all male threads. All final connections to light fixtures shall be through liquid-tight flexible conduits with weathertight connectors.

723.08.2--Conductors. All aerial conductors shall be triplex cable with an ACSR messenger. The conductor shall be aluminum with seven (7) strands. The messenger shall be the same size as the conductor with 6 to 1 stranding. The insulation shall be cross linked polyethylene, Type "XHHW-2" or "XLP".

Conduit installed conductors shall be type "THW" with standard annealed copper rated 600 volts.

Direct buried underground feeder or branch circuit shall be Type "UF".

All splices and connections shall be made in accessible boxes, switches, or at weatherheads.

Pressure type connectors shall be used. The connectors shall be well taped, rated for copper or aluminum

723.08.3--Lighting Assembly Requirements. All lighting assemblies shall be as shown on the plans. Fixtures shall be completely prewired with an integral photocell.

723.08.4--Lamps. Lamps shall be 250 or 400-watt clear high pressure sodium meeting or exceeding the following criteria:

Lamp Life at 10 hours per start, hours.....	24,000
Mean Lumens for 250-watt	27,000
for 400 watt.....	50,000
Burning Position	Operate in any position

723.08.5--Miscellaneous Material. Miscellaneous materials shall be furnished as shown on the plans, and as specified.

723.08.6--Timber Utility Poles. Timber utility poles shall be Southern Yellow Pine meeting the requirements of the latest edition of ANSI-05.1, "American National Standard for Wood Poles - Specifications and Dimensions", for Southern Pine poles having a fiber stress of 8,000 psi. The poles shall be free of all defects such as holes, splits, sap rot, etc. Maximum deviation from straight poles shall be 1/2" for each six (6) foot of length from surface of ground to top of pole when a string is stretched along its bow.

All poles shall be inspected and treated in accordance with applicable requirements of the American Wood-Preservers' Association (AWPA) and shall conform to Subsection 718.03 of the Standard Specifications.

723.08.7--Hardware. All hardware shall be approved for the use and location as shown on plans.

723.08.8--Safety Switch. All safety switches shall be General Duty 2-pole, 600-Volt, fused, with fuses sized as required, and in a NEMA 3R enclosure with a lock.

723.08.9--Junction Boxes. All junction boxes shall be cast aluminum. Locations of junction boxes will be as shown on plans.

DIVISION 800 - BRIDGES AND STRUCTURES**SECTION 801 - EXCAVATION AND FILL**

801.01--Description. Foundation excavation shall include the removal of all material, of whatever nature, necessary for the construction of foundations and substructures of bridges in accordance with the plans or as directed by the Engineer. When not shown as a pay item, it shall include the furnishing of all necessary equipment and the construction of all cribs, cofferdams, dewatering, etc. necessary for execution of the work. It shall also include the subsequent removal of cofferdams and cribs and the placement of all necessary backfill as hereinafter specified. It shall also include the disposal of excavated material, which is not required for backfill or other specified usage, in a manner and in locations that will not affect the carrying capacity of the channel or other drainage or be unsightly.

Unless a greater area is necessary for construction, the bridge site shall be the area defined in Subsection 101.02. Clearing and grubbing shall be in accordance with the provisions of Subsection 201.04.

All substructures, where practicable, shall be constructed in open excavation, and where necessary, the excavation shall be shored, braced, or protected by cofferdams in accordance with approved methods. When footings can be placed in the dry without the use of cribs or cofferdams, backforms may be omitted with the approval of the Engineer and the entire excavation filled with concrete to the top of the footing. The additional concrete required shall be placed at the expense of the Contractor.

801.02--Materials. Unless designated otherwise, all material used for backfill shall meet the requirements of Subsection 203.03.8.6.

801.03--Construction Requirements.

801.03.1--Preservation of Channel. Unless otherwise specified, no excavation shall be made outside of cribs, cofferdams, or sheet piling, and the natural stream bed adjacent to the structure shall not be disturbed without permission of the Engineer. If any excavation or dredging is made at the site of the structure before cribs or cofferdams are in place, the Contractor shall, without extra compensation and after the foundation base is in place, backfill all such excavation to the original ground surface or river bed with material satisfactory to the Engineer. Material deposited within the stream area from foundation or other excavation or from the filling of cofferdams shall be removed and the stream area freed from obstruction thereby.

801.03.2--Depth of Footings. The elevations shown on the plans for bottoms of footings shall be considered as approximate, and the Engineer may order in

writing changes in dimensions or elevations necessary for a satisfactory foundation.

801.03.3--Preparation of Foundations for Footings. All rock or other hard foundation material shall be cut to a firm surface, either level, stepped, or roughened as may be directed by the Engineer, and then cleaned of all loose material. All seams shall be cleaned out and filled with concrete, mortar, or grout.

When masonry is to rest on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation, and the final removal of the foundation material to grade shall not be made until just before the masonry is to be placed.

Excavation and preparation of foundations for footings for box bridges shall be in accordance with the provisions of Section 206.

801.03.4--Cofferdams and Cribbs.

801.03.4.1--General. Cofferdams and cribs shall be safely designed and constructed to adequate depths and heights, and be made as water-tight as is necessary for the proper performance of the work to be done inside them. In general, the interior dimensions of cofferdams and cribs shall be sufficient to permit construction of forms and the inspection of their exteriors and to permit pumping outside of the forms. Cofferdams or cribs which tilt or move laterally during the process of sinking shall be righted, reset, or enlarged so as to provide the necessary clearance. All corrective work shall be at the expense of the Contractor.

When conditions are encountered which, in the opinion of the Engineer, make it impracticable to dewater the foundation, the Engineer may require the construction of a concrete seal of the dimensions necessary. The foundation shall then be pumped out and the balance of the masonry placed in the dry. When weighted cribs are employed, and the weight is utilized to partially overcome the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys shall be provided to transfer the entire weight of the crib into the foundation seal. During the placing of a foundation seal, the water elevation inside the cofferdam shall be controlled to prevent any flow through the seal, and if the cofferdam is to remain in place, it shall be vented or ported at low water level.

801.03.4.2--Protection of Concrete. Cofferdams or cribs shall be constructed so as to protect green concrete against damage from a sudden rising of the stream and to prevent damage to the foundation by erosion. Timber or bracing that will extend into the substructure masonry shall not be left in cofferdams without written permission from the Engineer.

801.03.4.3--Drawings Required. The Contractor shall submit to the Engineer four copies of structural design analysis and detail drawings which shows the proposed method of constructing the cofferdam. These drawings shall include the types and sizes of sheeting, wales, bracing, and struts, the connections therefore, and the proposed method of installing, sealing, dewatering, cut-off and/or removal. The cofferdam analysis and details shall be prepared by and bear the seal of a Registered Professional Engineer experienced in cofferdam design.

The Registered Professional Engineer shall certify that the actual material and material fabrication used for cofferdam construction are capable of supporting the loads.

When submitting drawings and design analysis, the Contractor shall list the bent numbers on which the construction of cofferdams is proposed.

801.03.4.4--Removal. Unless otherwise provided, cofferdams or cribs with all sheeting and bracing shall be removed after the completion of the substructure. Care shall be taken not to disturb or otherwise injure the finished masonry.

801.03.5--Pumping. Pumping from the interior of a foundation enclosure shall be done so as to preclude the possibility of movement of water through fresh concrete. There shall be no pumping during the placing of concrete or for a period of at least 24 hours thereafter, unless it can be done from a suitable sump separated from the concrete work by a water-tight wall or other effective means.

Pumping to dewater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

801.03.6--Inspection. After each excavation is completed, the Contractor shall notify the Engineer, and no masonry shall be placed until the Engineer has approved the depth of the excavation and the character of the foundation material.

801.03.7--Backfill. Backfill of solid structures may commence upon removal of forms. Backfill of wall structures shall be in accordance with Subsection 601.03.6.3.

Adequate provision shall be made for thorough drainage of all backfilling. French drains shall be placed at weep holes as specified.

All excavated space not occupied by the permanent structure shall be backfilled to the surface of the surrounding ground or to the typical section indicated on the plans. All backfill shall be thoroughly compacted and sufficient allowance shall be made for settlement.

Where it provides drainage, bearing strength, or lateral support to the permanent construction, all backfilling shall be performed in accordance with the provisions of Subsection 203.03.8.6. In general, the top surface of backfilled area shall be neatly graded to the section indicated on the plans or established.

801.03.8--Approach Embankment. When approach embankments are required, they shall be constructed and will be paid for in accordance with Section 203.

801.04--Method of Measurement. Foundation excavation, satisfactorily performed, will be measured by the cubic yard in the original position with dimensions determined as follows:

- A. Bottom - the elevation of the bottom of the footing, seal, or web wall as applicable.
- B. Top - the elevation of the original ground or graded section, whichever is lower.
- C. Sides - vertical planes no more than 18 inches outside the outer edges shown on the plans, or directed, for the footing, seal and web wall.

The measurement will not include water or other liquids, but will include mud, muck, and other similar semi-solids.

Extra depth excavation, made necessary by the Engineer establishing the elevation of the footing or seal below the elevation shown on the plans, will be measured in cubic yards in its original position. This volume will be determined by multiplying the area of the excavation, as determined above, by the distance the footing or seal is lowered. This volume will be divided into the applicable increments indicated in Subsection 801.05.

When the material yielded from foundation excavation is insufficient, or is determined to be unsuitable, for backfill material, required backfill material ordered by the Engineer will be included in the measurement for the applicable item of excavation under Section 203. Other materials shown on the plans or ordered and used as backfill materials will be measured in accordance with the provisions governing the material specified.

Unless otherwise specified, haul of foundation excavation and materials for backfill will not be measured for separate payment.

When shown as a pay item, cofferdams will be measured as a lump sum quantity. This lump sum quantity includes all cofferdams necessary for footing construction.

Measurement for progress estimates will be based on the number of cofferdams completed as compared to the total number listed by the Contractor in accordance with Subsection 801.03.4.3.

801.05--Basis of Payment. Foundation excavation, measured to the elevation of the bottom of the footing or seal as shown on the plans, will be paid for at the contract unit price per cubic yard.

Extra depth excavation, required below the footing or seal elevation shown on the plans, will be paid for per cubic yard in accordance with the following schedule:

<u>Established Elevation of the Footing Below the Elevation Shown on the Plans</u>	<u>Payment Percent of Contract Price</u>
0.00 to 1.99 feet	100%
2.00 to 3.99 feet	120%
4.00 to 5.99 feet	150%
6.00 to 7.99 feet	165%
8.00 to 9.99 feet	195%
10.00 feet or more	230%

Selected backfill material, shown on the plans or ordered by the Engineer, to be obtained from sources other than from foundation excavation will be paid for at the contract unit price for the material specified and used.

All necessary cofferdams or cribs will be paid for at the contract lump sum price.

The prices thus paid shall be full compensation for completing the work.

All work required under this section for which no pay items are included in the proposal will not be measured for separate payment, compensation therefore shall be considered as included in the prices and payment for bid items.

Payment will be made under:

- 801-A: Foundation Excavation for Bridges
- per cubic yard
- 801-B: Cofferdams
- lump sum

SECTION 802 - SHEET PILING

802.01--Description. This work consists of furnishing and installing permanent sheet piling as shown on the plan, or ordered by the Engineer to be left in place as part of the finished structure. Except where indicated as a pay item in the plans, no compensation will be allowed for furnishing and installing temporary

sheet piling and appurtenances. Temporary sheet piling will ONLY be paid for when a pay item is included in the plans.

802.02--Materials.

802.02.1--Concrete Sheet Piles. Concrete sheet piles shall be in accordance with the detailed design. The requirements governing their manufacture and installation shall conform, in general, to those governing concrete bearing piles.

802.02.2--Steel Sheet Piles. Steel sheet piles shall conform to the requirements of Subsection 719.05 and shall be of the type and weight designated. The piles, when in place in the completed structure, shall be practically water-tight at the joints. Painting of steel sheet piles shall conform to Section 814.

802.03--Construction Requirements. Construction requirements for sheet piling shall conform to the applicable requirements of Section 803.

Temporary sheet piling shall be a steel sheet pile retaining wall constructed as indicated on the plans. Painting of the sheet piling will not be required. The sheet piling shall be removed upon completion of the work and the area shall be restored as directed by the Engineer.

802.04--Method of Measurement. Permanent sheet piling will be measured by the square foot, on the basis of the piles driven as approved by the Engineer. Cut-offs will be deducted from the measurement. Unless shown as a pay item, no measurement for extra compensation will be made for such temporary sheet piling required for foundations and in conjunction with bridge excavation not designated for payment.

Temporary steel sheet piling will be measured by the square foot, on the basis of the piles driven as approved by the Engineer. Temporary steel sheet piling will only be measured for payment when a pay item is included in the plans.

802.05--Basis of Payment. Permanent and temporary sheet piling, measured as prescribed above, will be paid for by the square foot, which price shall be full compensation for completing the work.

Payment will be made under:

802-A: Permanent Steel Sheet Piling	- per square foot
802-B: Permanent Concrete Sheet Piling	- per square foot
802-C: Temporary Steel Sheet Piling	- per square foot

SECTION 803 - DEEP FOUNDATIONS**803.01--General.**

803.01.1--Description. This work consists of furnishing and installing deep foundations in accordance with these specifications and in reasonable conformance with the lines, elevations, and spacings shown on the plans. It shall also consist of furnishing all required labor, tools, and equipment to determine the bearing value of the deep foundation by static load testing, by dynamic load testing, and/or by driving of the specified test piles.

803.01.2--Order Lists for Deep Foundations. Lengths found in the plans are estimated lengths for bid purposes. Unless otherwise specified or authorized in writing by the Bridge Engineer, all permanent deep foundations shall be installed within the prescribed tolerances specified herein and to the depths and/or lengths indicated on the itemized Order List furnished by the Engineer. The Order List shall be furnished after bearing has been verified either through static load testing, dynamic load testing, and/or driving of the specified test piles.

The Contractor shall furnish or install driven piles and/or drilled shafts in accordance with an itemized list furnished by the Engineer. The Order List will show the required length of the piles or drilled shafts for each bridge bent or footing.

803.02--Materials. All materials shall conform to the applicable requirements set forth in Sections 710, 711, 719, 804, and 814.

Driven piles shall conform to all applicable requirements set forth in Section 719 and the plans. Paint for steel piles or steel shells shall conform to the applicable requirements of Sections 710 and 814.

Drilled shaft concrete shall conform to the requirements of Section 804 for Class "DS" concrete. All reinforcing steel shall conform to the requirements of Section 711 of the Specifications.

803.03--Construction Requirement. This work shall consist of furnishing all labor, materials, equipment and services necessary to install driven piles of the prescribed type in accordance with these specifications and in conformance with the lines, elevations, and spacings shown on the plans.

This work shall also consist of furnishing all labor, materials, equipment and services necessary to perform all operations to complete the drilled shaft installations in accordance with these specifications and with the details and dimensions shown on the plans. Drilled shafts shall consist of reinforced or nonreinforced concrete with or without concrete bell footings.

803.03.1--Driven Piles.

803.03.1.1--General. Unless otherwise specified or authorized by the Bridge Engineer, all permanent production piles shall be driven in a continuous operation, to the full lengths indicated on the itemized order list furnished by the Bridge Engineer.

803.03.1.2--Accuracy of Installation. Driven piles in trestle bents shall be driven to within a tolerance of 1/4 inch per foot from the vertical or from the batter shown on the plans. Piles to be incorporated into a cap or footing shall not be out of the position shown on the plans by more than six inches. In all cases, piles shall be driven so that they will not be excessively stressed to place them in the proper location in the cap or footing. Excessive manipulation of the piles will not be permitted, and the Contractor shall redrive or use other satisfactory methods to avoid such manipulations. No shimming on tops of piles will be permitted.

803.03.1.3--Extensions, Build-ups and Splices. If determined by the Engineer to be necessary, production piles that are extended below cut-off shall be extended, built-up, or spliced in accordance with the plans to the extent established by the Bridge Engineer. Extensions or build-ups will not be measured for payment as such, but will be included in the total length of piling in the finished structure.

803.03.1.4--Cut-Offs. If it is determined by the Engineer that the pile has reached practical refusal above pile cut-off elevation but below the prescribed minimum tip elevation shown in the plans then the Contractor will be allowed to cut off the pile at the cut-off elevation.

803.03.1.5--Driven Pile Types. Driven piles shall be of the type listed below unless otherwise specified in the plans.

803.03.1.5.1--Concrete Piles. Concrete piles shall be the size and shape specified. Reinforcement, unless otherwise designated, shall have a clear distance of at least two inches from the face of the pile. When the piles are for use in salt water or alkali soils this clear distance shall be at least three inches.

803.03.1.5.2--Steel Piles. Full-length piles shall be used unless splicing is approved in writing by the Bridge Engineer. When permitted, splicing shall be in accordance with the notes and details shown on the plans.

803.03.1.5.3--Timber Piles. Specified timber piles or timber piles used for temporary construction shall meet the requirements set forth in Section 820.

803.03.1.5.4--Special Piles. Piles not of the type specified above, but called for in the plans or additional specifications shall meet the general requirements contained therein.

803.03.1.6--Preparation for Driving.

803.03.1.6.1--Excavation. When a pile cap is located below the ground line, piles shall not be driven until the required excavation is completed. All material forced up between the piles shall be removed to the correct elevation at the Contractor's expense before concrete for the foundation is placed.

803.03.1.6.2--Pile Cushions. Suitable cushioning material shall be used between the driving helmet and the top of the pile. This is especially critical for concrete piles. The Contractor should submit the type material, cross-sectional area and total thickness of the pile cushion. This information shall be submitted to the Engineer for approval on the completed *Pile Driving Equipment Data Form*. The pile cushion shall be approved with the pile driving system and is subject to satisfactory field performance.

803.03.1.7--Method of Installation and Driving System.

803.03.1.7.1--General. The pile driving system shall be defined as all equipment necessary to install the specified piles to the required minimum tip elevations specified in the plans. The pile driving system shall include the pile hammer, hammer leads, followers, water jets, drilling equipment for pre-formed pile holes, and templates, if necessary.

803.03.1.7.2--Submittal of Pile Driving System Data. The Contractor shall submit to the Engineer all technical specifications and operating instructions relating to the pile driving system that is to be used to drive the piling. The Contractor shall also submit a completed *Pile and Driving Equipment Data Form* to the Engineer at the pre-construction conference or no later than 14 days prior to the anticipated driving date. The Contractor will not be allowed to install any piling until the driving system has been approved in writing by the Engineer. The Department will use the submitted information to perform wave equation analysis and prepare a summary report of the wave equation results. The wave equation analysis and other data shall be used to assess the ability of the proposed systems to install the piles to the desired penetration depth within the AASHTO standards for driving stresses.

The Engineer will notify the Contractor of any additional information required and/or changes that may be necessary to meet the project requirements. Any parts of the driving system that are unacceptable will be rejected and the Contractor will submit changes. Review of these changes will be completed within seven (7) days and the Contractor notified of their acceptance or rejection. Approval of the proposed driving system by the Engineer for driving of test piles

shall be based upon the wave equation analysis indicating that the proposed driving system is acceptable.

All production piles shall be driven with the hammer bearing the same Serial Number submitted on the *Pile and Driving Equipment Data Form* and used to drive the test piles. In the event multiple hammers of differing type are used on the same bridge, the Contractor shall submit to the Engineer for approval a completed *Pile and Driving Equipment Data Form* for each hammer and specify the bridge bents in which each hammer will be used. This will allow the Department the opportunity to develop appropriate driving and acceptance criteria specific to each hammer.

A different pile driving system, modifications to the existing system, or different pile installation procedures shall be proposed by the Contractor if the pile installation stresses predicted by the wave equation analysis or calculated by the PDA are not within the AASHTO values. All approvals are conditional and subject to trial and satisfactory performance in the field. Unless otherwise permitted by the Bridge Engineer in writing, test piles and permanent piles shall be driven with the approved driving system.

803.03.1.7.3--Pile Hammers. Piles may be driven with an approved single-acting or double-acting pile hammer in combination with water jets or pre-formed pile holes. The pile driving system shall be constructed so as to afford freedom of movement of the pile hammer and to drive the piles to the required depth within the tolerances specified without undue injury to the piles.

The pile hammer shall be in good working condition and produce the energy required to install piles to the depth or penetration required in the plans. Single or double-acting Steam/Air, Diesel/Internal Combustion, or Hydraulic hammers may be submitted for review and approval.

In no case shall a gravity or drop hammer be used to drive concrete or steel piles supporting the permanent bridge structure. A drop hammer may be used to install timber or steel piles for temporary construction, but in no case shall a gravity or drop hammer be used to drive concrete piles.

803.03.1.7.4--Driving Appurtenances.

803.03.1.7.4.1--Pile Hammer Leads. Either fixed leads or swinging leads may be used. Swinging leads shall be used in combination with rigid templates approved by the Engineer. Battered piles shall be driven in inclined leads or multiple rigid templates capable of holding the pile in the proper position during driving.

803.03.1.7.4.2--Pile Cushions. Suitable cushioning material shall be used between the driving cap and the top of the pile. The cushion material shall

protect the pile top during driving and shall be constructed such that the hammer energy is uniformly distributed to the pile top. The pile cushion shall be changed prior to driving each pile. In addition, if the cushion material becomes highly compressed, or chars or burns during the driving operations or damage occurs at the pile top, it shall be replaced. The type of material and dimensions of the pile cushion shall be included in the appropriate place on the *Pile and Driving Equipment Data Form*.

803.03.1.7.4.3--Water Jets. Water jets may be used in conjunction with the pile hammer to install piles to the required depth or penetration called for in the plans. The use of water jets, where the stability of embankments or other improvements would be endangered, will not be permitted. When water jets are used, the number of jets and the volume and pressure of water shall be sufficient to adequately facilitate driving without undue damage to the pile or the soil adjacent to or below the pile. Unless otherwise specified, water jets shall not be used within five feet of the final tip elevation of the pile. In addition, it shall be the Contractor's responsibility to withdraw the water jets sufficiently above the five foot requirement to obtain the specified bearing at the required cut off elevation.

In the event a jetted pile fails to obtain the specified bearing at the required penetration and a determination is made by the Engineer that the Contractor has failed to properly control the jetting operation, the Contractor should submit detailed corrective measures for founding the pile to the Engineer for approval. Any required corrective measures to the pile due to the Contractor's operation shall be performed at no additional cost to the State.

803.03.1.7.4.4--Followers. Followers are considered to be part of the Driving System and should be included for approval with the *Pile and Driving Equipment Data Form*. Included with the submittal should be a dimensioned sketch of the follower. Also, the type(s) of materials that the follower is made of and the weight of the follower should be included as well as cushion information.

803.03.1.7.4.5--Pre-formed Pile Holes. The Bridge Engineer will make all determinations as to the necessity for pre-formed pile holes and the size and maximum depth of each hole required or permitted.

If it is determined from the Geotechnical Investigation or from the site survey that pre-formed pile holes are necessary, a pay item and estimated quantities will be included on the plans, and the Bridge Engineer will furnish the Contractor with an itemized list showing the location, size and bottom elevation of each hole.

If the plans do not specify pre-formed pile holes and the Bridge Engineer, with the concurrence of the Construction Engineer, determines during construction that subsurface conditions are encountered that necessitate pre-formed pile holes, at certain locations, an adjustment in the contract unit price for furnishing and

driving piling at these locations may be made under the provisions of Subsection 104.02.

If in the judgment of the Engineer pre-formed pile holes are not required and the Contractor desires to use them, the Contractor may be permitted to do so under conditions prescribed by the Bridge Engineer and at no additional cost to the State.

803.03.1.7.4.6--Additional Equipment. When a minimum penetration is indicated on the plans and is not obtained by the use of an approved hammer, the Contractor shall submit to the Engineer for approval a completed *Pile and Driving Equipment Data* Form for a heavier hammer or resort to jetting at no additional cost to the State.

803.03.1.8--Defective Piles. Prior to driving, piles shall not be subjected to handling that causes damage either through bending, crushing or spalling of concrete, or deformation of the steel. All piles damaged because of internal defects or by improper driving, driven out of the proper location or driven below the specified elevation shall be corrected at the Contractor's expense by one of the following methods approved by the Engineer for the pile in question:

- 1) The pile shall be withdrawn and replaced by a new and, if necessary, a longer pile.
- 2) A second pile shall be driven adjacent to the defective or low pile.
- 3) The pile shall be spliced or built up or a sufficient portion of the footing shall be extended to properly embed the pile. All piles pushed up by the driving of adjacent piles or by any other cause shall be driven down to grade.

803.03.1.9--Determination of Bearing Value of Piling.

803.03.1.9.1--General. The ability of the pile to transfer load to the ground will be determined to the satisfaction of the Bridge Engineer. Such determination will be made by the Geotechnical Engineer and Foundation Engineer from a subsurface investigation conducted by the Geotechnical Branch of Materials Division and test piles that are driven out-of-position or driven to be incorporated in the structure as permanent piles.

803.03.1.9.2--Determination of Bearing Value by Pile Hammer Formulas. When load testing, either static or dynamic, is not called for in the plans, the safe bearing values will be determined by the following formulas or as directed by the Engineer.

$$P = \frac{2WH}{S+0.2} \quad \text{for single-acting steam/air hammers and open cylinder diesel hammers}$$

$$P = \frac{2H(W+Ap)}{S+0.1} \quad \text{for double-acting steam hammers}$$

Where

- P = safe bearing value in pounds
- W = weight, in pounds, of striking parts of hammer
- H = height of fall in feet
- A = area of piston in square inches
- p = steam/air pressure in pounds per square inch at the hammer
- S = the average penetration in 10 blows for gravity hammers and the last 10 to 20 blows for steam/air hammers.

These formulas are applicable for the following conditions only:

- The hammer has a free fall.
- The pile head is not crushed.
- The penetration is reasonably quick and uniform.
- There is no appreciable bounce after the blow.
- A follower is not used.

Where there is appreciable bounce of the hammer, twice the height of the bounce shall be deducted from “H” to determine its value in the formula.

When water jets are used, the bearing value shall be determined by the above formulas from the results of driving after the jets have been withdrawn, or a static or dynamic load test has been conducted.

Formulas for pile hammers not covered herein must be approved by the Bridge Engineer.

803.03.1.9.3--Determination of Bearing Value by PDA Monitoring (Dynamic Load Testing).

803.03.1.9.3.1--Description. This work consists of furnishing all labor, materials, equipment and services necessary to perform all operations to complete the determination of bearing value of piling by Department forces using a Pile Driving Analyzer (PDA) and associated equipment. The dynamic load testing measurements will be performed in accordance with the plans and the guidelines given herein.

803.03.1.9.3.2--Scope and Sequence of Construction. The dynamic measurements will be performed on the piles as detailed below for the purpose of obtaining ultimate pile bearing capacity, pile driving stresses, pile integrity, and the pile driving system efficiency. Unless otherwise directed in the plans, the

sequence of construction outlined below shall not be deviated from unless an alternate sequence of construction is approved in writing by the Engineer.

- 1) When called for in the plans, Load Testing With Special Instrumentation and/or Conventional Static Load Testing will be performed on piles as detailed. Piles to be load tested shall be driven in the location shown in the plans with PDA monitoring under initial drive and have restrikes performed.
- 2) When called for in the plans, PDA Test Piles will be driven with PDA monitoring under initial drive and have restrikes performed as detailed below. The test piles will be used as production piles and be incorporated into the bridge structure.
- 3) Any production piles determined by the Engineer to require PDA monitoring during initial drive or require PDA restrikes.

803.03.1.9.3.3--PDA Monitored Driving and/or Restrike of Piling.

803.03.1.9.3.3.1--General. When called for in the plans or the Engineer, a Pile Driving Analyzer (PDA) and instrumentation will be used to obtain dynamic measurements during pile driving and pile restrikes. The analysis of the monitoring will be the responsibility of the Department. The Contractor shall give notice to the State Geotechnical Engineer at least 14 calendar days before the scheduled date of driving piles to be monitored. The Contractor shall confirm the driving date 3 calendar days prior to the scheduled driving date.

803.03.1.9.3.3.2--Contractor Requirements. The Contractor shall be responsible for furnishing the following:

- 1) A power supply providing at least 1800 watts of 115-volt AC power with a frequency of 60 Hz at the driving site.
- 2) Prepare the driving site.
- 3) Supply the labor necessary for attaching the dynamic monitoring instrumentation to the piles. The Contractor shall make one of their personnel available to place the transducers on the piles after the piles have been placed in the leads.
- 4) Drive the piles as directed by the Engineer.

The Contractor shall make the piles available prior to driving for drilling and tapping of holes that are necessary for attachment of instrumentation. The expected delay for attaching the instruments to the pile will be approximately one (1) hour. The Contractor shall use reasonable care when working with piles when instruments are installed and shall replace any damaged equipment caused by Contractor error at no additional cost to the State.

803.03.1.9.3.3.3--Driving Requirements. Piles to be used in the determination of pile bearing by PDA monitoring shall be driven with PDA instrumentation attached to the pile and shall have a PDA monitored 1-day and 7-day restrike performed after the initial pile driving. The Engineer may modify the waiting periods that are required before the restrikes are performed. When a static load test is to be performed, the 7-day restrike should be eliminated and a PDA monitored restrike done within 24 hours of completion of the static load test. When deemed necessary by the Engineer, permanent piles may have PDA monitored restrikes performed to confirm or supplement design requirements.

Restrikes shall be performed with a warm hammer operating at normal efficiency. A warm hammer is defined as a hammer that has applied a minimum of 20 blows to another pile or a dummy block immediately before being used in a restrike. The restrike shall consist of striking the pile for 50 blows or until the pile penetrates an additional three inches, whichever occurs first. In the event the pile movement is less than one inch after 15 blows during the restrike, the restrike may be terminated.

803.03.1.9.4--Determination of Bearing Value by Static Load Testing. When called for in the plans or directed by the Engineer, static load testing will be conducted to determine the ultimate bearing capacity of piles. Depending upon the conditions encountered in the field, the Bridge Engineer may increase or decrease the number of static load tests required.

803.03.1.9.4.1--Load Testing of Piling With Special Instrumentation.

803.03.1.9.4.1.1--General. When called for in the plans, out-of-position test piles shall be driven with special instrumentation attached for the purpose of conducting a load test as directed by the plans. A waiting period of seven (7) calendar days shall be observed beginning after the out-of-position test pile is driven. After the waiting period, the pile shall be load tested to failure as directed by the plans. The Contractor will be responsible for furnishing all materials, equipment, labor, and incidentals necessary for conducting the load test. The Contractor shall subcontract and supply all instrumentation, conducting, and reporting of the load test to the company supplying the instrumentation, with the cost included in prices bid for items contained in the contract. Reaction systems and extra pile installations as required in the plans shall be absorbed in the cost for the load test on the pile.

803.03.1.9.4.1.2--Materials. When called for in the plans, instrumentation shall be supplied to meet the requirements set forth in the plans. Instrumentation required in the plans are subject to prior approval by the State Geotechnical Engineer. Additional equipment that may be required are as follows.

- 1) Materials sufficient to construct a stable reference beam system for monitoring deflection of the pile during testing, supported at a minimum distance of three (3) diameters from the center of the pile to prevent disturbance of the reference system.
- 2) Materials sufficient to construct a protected work area including provisions such as a tent or shed for protection from inclement weather for the load test equipment. The work area shall be of size and type required by the Engineer.
- 3) In the case of an out-of-position pile, the pile shall be removed or broken-off such that the remaining pile is at least two (2) feet below the ground or mud line.

Materials supplied, which do not become a part of the finished structure, shall be removed from the job site.

803.03.1.9.4.2--Conventional Static Load Testing of Piling.

803.03.1.9.4.2.1--General. When called for in the plans or directed by the Engineer, the pile to be load tested shall be installed as indicated in the plans to the specified tip elevation or as directed by the Engineer. Once the pile is in place, a static load test will be conducted to determine the ultimate bearing capacity of the pile. A waiting period of seven (7) calendar days shall be observed beginning after all the reaction piles have been driven but prior to static load testing.

803.03.1.9.4.2.2--Contractor Requirements. The Contractor shall be responsible for furnishing the following:

- 1) A reaction load frame capable of resisting a total load of at least five (5) times the design load called for in the plans. The frame shall consist of a beam or girder that will carry the above load while sustaining only minor deflections in the reaction system. The beam or girder shall be attached to a system of anchor piles. The anchor piles shall not be closer to the test pile than five times the diameter (width) of the pile to be tested. See Figure 1 for additional reaction load frame requirements.
- 2) A hydraulic jack that has been calibrated for the full range of anticipated loads in accordance with AASHTO Designation: T 67 (ASTM Designation: E 4) at least once. The maximum anticipated load shall be assumed to be five (5) times the design load called for in the plans. The pressure gauge shall be calibrated within one year preceding the time of use and whenever there is a reason to doubt the accuracy of the results. The Contractor shall furnish a certificate of calibration for the hydraulic jack at the time of static load testing.

- 3) A measuring frame or reference beam for measuring the movement of the pile during testing. Two dial gauges, supplied by the Department, will be attached to the pile as indicated on Figure 1. Each dial gauge shall be actuated by its stem or by a stem attachment resting on the measuring frame. The supports for the measuring frame shall be placed the maximum practical distance from the test pile and the anchor piles for the reaction load frame. In no case should the measuring frame be affected by movement of the test pile or the anchor piles.
- 4) In the case of an out-of-position pile, the pile shall be removed or broken-off such that the remaining pile is at least two (2) feet below the ground or mud line.

803.03.1.9.4.2.3--Methods and Equipment. Personnel from the Geotechnical Branch of MDOT will assist in the setup and will be responsible for the running of the test. The Department will be responsible for providing the load cell, dial gauges and associated equipment. The static load test will be performed using ASTM Designation: D 1143, quick test methods. A waiting period of seven (7) calendar days shall be observed beginning after all the reaction piles have been driven but prior to static load testing.

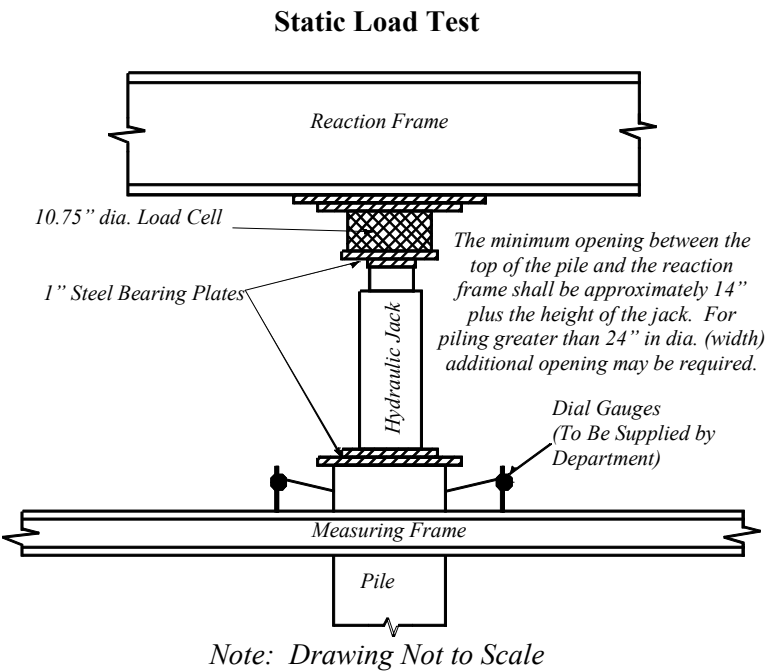


Figure 1

803.03.1.10--Pile Acceptance. The safe allowable load for each type, size, and length of pile will be determined by the Bridge Engineer. Acceptance criteria for

permanent production piles will be supplied by the Bridge Engineer with the final order list.

803.03.1.11--Test Piles. When required in the plans, the Contractor shall furnish and install test piles of the sizes, types, and lengths at the locations shown on the plans. The number of test piles may be increased or decreased by the Bridge Engineer as field conditions warrant. If determined by the Engineer to be necessary, test piles shall be extended, built-up, or spliced and in the case of steel piles driven further if deemed necessary, to the depths established by the Bridge Engineer. Similarly, the Contractor may be required to drive test piles below cut-off and extended as necessary.

803.03.2--Drilled Shafts.

803.03.2.1--Submittals.

803.03.2.1.1--Qualification of Contractor. The person(s) or firm directing the work described in this specification shall be knowledgeable of drilled shaft installation procedures and shall have installed drilled shafts of both diameter and length similar to those shown in the plans in accordance with the following minimum experience requirements:

- 1) A drilled shaft Contractor shall have a minimum of three (3) years of drilled shaft installation experience prior to the bid date for this project; or,
- 2) A Contractor without prior drilled shaft experience shall employ a superintendent with a minimum of fifteen years of drilled shaft experience prior to the bid date of this project.

A Contractor with limited drilled shaft installation experience may use a combination of their experience and the superintendent's experience, with each five years of experience of the superintendent counting as equivalent to one year's experience of the Contractor. A signed statement listing the applicable work experience of the drilled shaft Contractor shall be submitted to the Engineer at the Preconstruction Conference, or no later than 45 calendar days prior to drilled shaft construction.

At the Preconstruction Conference, or no later than 45 calendar days prior to beginning drilled shaft construction, the Contractor shall furnish the Engineer evidence of the following:

- 1) A signed statement from the drilled shaft superintendent responsible for the drilled shaft installation that the project site has been visited, and that all the subsurface information has been inspected. This information includes the soil profiles and/or boring logs furnished in the plans, soil

samples and rock cores, and the Geotechnical Investigation. All the above information may be obtained from the Geotechnical Branch of Materials Division.

- 2) A signed statement from the drilled shaft Contractor detailing their ability to complete a project of this type. This shall be supported by a list containing a detailed description of at least three (3) projects completed in the last three (3) years on which the drilled shaft Contractor and/or superintendent has installed or supervised installation of drilled shafts similar in size to those shown in the plans, and utilized excavation methods similar to those anticipated for this project. This list of projects shall contain names and phone numbers of the project owner's representatives who can verify the drilled shaft Contractor's participation on the project, and the names of the superintendents who were in charge of the drilled shaft operations.
- 3) Name and experience records of the drilled shaft superintendent and driller who will perform the required work.

The Engineer will evaluate the evidence of qualifications submitted for conformance with these specifications. Should the information submitted be incomplete or not conform to the project specifications, the information will be rejected and the Contractor shall submit changes for reevaluation.

If the Contractor wishes to replace the drilled shaft superintendent or the driller during the life of the project, the name and experience record of their replacement shall be submitted to the Engineer for approval.

803.03.2.1.2--Drilled Shaft Installation Plan. At the Preconstruction Conference, or no later than 45 calendar days before drilled shaft construction begins, the Contractor shall submit to the Engineer an installation plan for review. This plan shall provide information on the following:

- 1) A copy of the proposed drilled shaft concrete mix design as submitted with the Contractor's Concrete Quality Control Plan. Construction of the trial shaft(s) will not commence until the drilled shaft concrete mix design has been approved in accordance with Section 804, Concrete for Bridges and Structures.
- 2) List and size of proposed equipment including cranes, drill rigs, augers, bits, bailing buckets, digging buckets, final cleaning equipment, slurry tanks, desanding equipment, slurry pumps, tremies, pump lines, concrete pumps, casings, etc.
- 3) Details of the method of exploration including the equipment, if required.
- 4) Details of the sequence of construction operations and sequence of shaft construction within bents or shaft groups.

- 5) Details of shaft excavation method(s).
- 6) Details of slurry type and usage, including proposed methods to mix, circulate and desand slurry when slurry is required.
- 7) Details of proposed methods to clean the drilled shaft excavation upon reaching the minimum required tip elevation.
- 8) Details of reinforcement placement including the method of support while aligning the cage for placement into the drilled shaft excavation and the centering devices to be used to center the cage and assure minimum outside clear space shown in the plans.
- 9) Details of concrete placement including proposed operational procedures for concrete tremie or pump, including initial placement, raising during placement, and overfilling of the shaft concrete, and the ability of the concrete supplier to provide a continuous pour for the anticipated volumes.
- 10) Details of casing installation and removal, when required.
- 11) Details of any required load tests including equipment and recent calibrations for any jacks supplied by the Contractor.

The Engineer will evaluate the Contractor's *Drilled Shaft Installation Plan* for conformance with the plans and specifications, after which the Engineer will notify the Contractor within 14 calendar days of any additional information and/or changes that may be required. Any part of the plan that is unacceptable will be rejected and the Contractor shall submit changes for reevaluation.

All approvals given by the Engineer shall be subject to trial and satisfactory field performance, and shall not relieve the Contractor of the responsibility to satisfactorily complete the work as detailed on the plans and in the specifications.

803.03.2.2--Trial Shaft Construction. The Contractor shall demonstrate the adequacy of the methods and equipment during construction of an out of position trial shaft. This trial shaft shall be positioned as far as practical from the production shafts, in the position shown on the plans or as directed by the Engineer, and shall be drilled to the minimum tip elevation as required on the plans. When shown on the plans, the reaming of bells at specified trial shafts will be required to establish the feasibility of bell in a specific soil strata. Failure to demonstrate the adequacy of the Contractor's methods and equipment to construct the trial shaft shall be cause for the Engineer to require alterations in equipment and/or method by the Contractor, to eliminate unsatisfactory results. Backfilling of unsuccessful excavations and any additional trial shafts required to demonstrate the adequacy of altered methods of construction or equipment shall be performed by the Contractor at no additional cost to the State. Once the Contractor has completed the excavation for the trial shaft to the satisfaction of the Engineer, the Contractor shall set the reinforcement and pour the concrete to finish construction of the trial shaft. This shall be demonstration that the entire

plan for drilled shaft construction is satisfactory. Failure to successfully construct the trial shaft shall be cause for rejection of the trial shaft, and shall be reason for the Engineer to require alterations necessary to eliminate unsatisfactory results. Additional trial shafts to demonstrate correction of deficiencies shall be at the Contractor's expense.

If differing soil conditions require two (2) or more methods for construction of production shafts, said methods shall be demonstrated by trial shaft prior to construction of any production shaft.

After the successful trial shaft has been completed, the Contractor shall submit in writing for review the successful methods and equipment used. This submittal, once reviewed, will serve as the approved method of construction for all the production shafts covered by that successful trial shaft. Once approval has been given to construct production shafts, no changes will be permitted in the methods, equipment, drilled shaft superintendent, or driller from those used during the construction of the trial shaft without written approval of the Engineer.

Trial shafts shall be cut off two (2) feet below finish grade or two (2) feet below the mudline and left in place. The portions of the shafts cut off and removed shall remain the property of the Contractor. The disturbed areas in the vicinity of the trial shaft shall be restored as nearly as practical to their original condition.

803.03.2.3--Construction Methods and Equipment.

803.03.2.3.1--General.

803.03.2.3.1.1--Protection of Existing Structures. When the plans require drilled shaft excavations within close proximity to existing structures or utilities, the Contractor shall take all reasonable precautions to prevent damage to such structures. This shall include newly constructed shafts. If not otherwise provided for in the plans, the Contractor shall be solely responsible for evaluating the need for, design of, and providing all reasonable precautionary features to prevent damage. These measures shall include, but are not limited to, selecting construction methods and procedures that will prevent caving of the shaft excavation, and monitoring and controlling the vibrations from construction activities, including the driving of casings, driving of sheeting, or from blasting, when permitted. Advancing an uncased drilled shaft excavation or the use of a vibratory hammer to install casings within 30 feet of a newly constructed shaft will not be permitted unless the concrete in that shaft has attained a compressive strength of 2500 p.s.i., as determined by cylinder tests. Based upon observations, the Engineer may adjust this distance accordingly. During shaft construction, the Contractor shall take into account and make provisions for vibrations caused by activities other than the Contractor's, such as adjacent traffic.

Such structures shall be monitored for settlement in an approved manner, recording elevations to 0.01 foot. The number and location of monitoring points shall be as approved by the Engineer. Elevations shall be taken before construction begins, during the driving of any required casings, and during excavation or blasting as directed by the Engineer.

When shown on the plans, or as directed by the Engineer, the Contractor shall monitor and record vibration levels during the driving of casings, sheeting, or during blasting operations. Vibration monitoring equipment shall be capable of detecting particle velocities of 0.1 inch/second or less.

At any time the Contractor detects settlement of 0.03 foot, vibration levels reaching 1.5 inches per second, or damage to the structure, the Contractor shall immediately stop the source of vibrations, backfill the excavation, and contact the Engineer for instructions.

803.03.2.3.1.2--Construction Sequence for Site Preparation. Excavation to the plan footing elevation, if required, shall be completed before shaft construction begins. Any disturbance to the footing area caused by shaft installation shall be repaired by the Contractor prior to the footing pour.

When drilled shafts are to be installed in conjunction with embankment placement, the Contractor shall construct the drilled shafts after placement of the embankment material.

803.03.2.3.1.3--General Methods and Equipment. The Contractor shall perform the excavations required for the shafts and bell footings, through whatever materials encountered to the dimensions and elevations shown on the plans, or otherwise required by the specifications, at no additional cost to the State. The Contractor's methods and equipment shall be suited for the intended purpose and the materials encountered.

Drilled shafts shall be constructed by either the dry method, wet method, casing method, or permanent casing method, as necessary to produce a sound, durable, concrete foundation free of defects. The permanent casing method shall be used only when required by the plans or authorized by the Engineer. When the plans describe a particular method of construction, this method shall be used unless otherwise permitted by the Engineer. The Engineer may permit an alternate method than designated on the plans, only after successful construction of an out of position trial shaft. When the plans do not describe a particular method, the Contractor shall utilize a method on the basis of its suitability to the site conditions. Blasting shall only be permitted if specifically stated on the plans or approved by the Engineer.

Once approval is given to construct production shafts, no changes will be permitted in the methods or equipment from those used in constructing the accepted trial shaft without written approval of the Engineer.

803.03.2.3.2--Dry Construction Method. The dry construction method shall be used only at sites where the groundwater level and soil conditions are suitable to permit construction of the shaft in a relatively dry excavation, and where the sides and bottom of the shaft may be visually inspected by the Engineer prior to placing the concrete. The dry method consists of drilling the shaft excavation, placing the reinforcing cage, and concreting the shaft in a relatively dry excavation.

The dry construction method shall be used only when the trial shaft excavation demonstrates that: concrete can be placed with less than three (3) inches of accumulated water in the bottom of the shaft; the sides and bottom of the hole remain stable without caving, sloughing, or swelling over a two-hour period immediately following completion of the excavation; and any loose material and excess water can be satisfactorily removed prior to inspection and prior to concrete placement.

803.03.2.3.3--Wet Construction Method. The wet construction method shall be used at all sites where it is impractical to provide a dry excavation for placement of the shaft concrete.

The wet construction method consists of drilling the shaft excavation below the water table, keeping the shaft filled with water or mineral slurry, not a separate pay item, desanding or cleaning the slurry, final cleaning of the excavation by means of a bailing bucket, air lift, submersible pump or other approved devices, and placing the rebar cage and the shaft concrete, with a tremie or concrete pump beginning at the shaft bottom, which displaces the water or slurry as the shaft is concreted. Temporary surface casings shall be provided to aid shaft alignment and position and to prevent sloughing of the top of the shaft, except when the Contractor demonstrates to the satisfaction of the Engineer that the surface casing is not required.

Where drilled shafts are located in open water areas, the shafts shall be constructed by the wet method using casings extending from above the water elevation into the ground to protect the shaft concrete from water action during placement and curing of the concrete. The casing shall be installed in a manner that will produce a positive seal at the bottom of the casing so that there is no intrusion or extrusion of water or other materials into or from the shaft excavation. Casings for this application may include multiple casings, temporary casings, and/or designed permanent casings.

The wet construction method may be used in combination with the dry method and temporary or permanent casing methods.

803.03.2.3.4--Casing Construction Method. The casing construction method may be used at sites when the dry or wet construction methods are inadequate to prevent hole caving or excessive deformation of the hole. In this method, the casing may be either placed in a predrilled hole if no caving, swelling, or yielding occurs, or advanced through the ground by twisting, driving, or vibration before being cleaned out.

When a formation is reached that is nearly impervious, a casing shall be placed in the hole and seated in the nearly impervious formation. Drilling may proceed as with the dry method to the projected depth. If seepage occurs at this point, temporary casing may be advanced further to create the dry condition. In the event seepage conditions prevent use of the dry method, excavation shall be completed using wet methods. The placement of the concrete shall proceed as with the wet or dry method, except that the casing shall be withdrawn after the concrete is placed.

When caving soils occur near the ground surface and/or if the top of the concrete for the drilled shaft is below the ground surface, the Contractor shall set a suitable temporary removable surface casing. The minimum surface casing length shall be the length required to prevent caving of the surface soils and to aid in maintaining shaft position and alignment. Predrilling with slurry and/or overreaming to the outside diameter of the casing may be acceptable if required to install the surface casing at some sites.

Where drilling is through materials having a tendency to cave, the drilling shall be advanced by drilling in a mineral slurry. In the event that a caving layer or layers are encountered that cannot be controlled by slurry, the Contractor shall install temporary removable casing through such caving layer or layers. Overreaming to the outside diameter of the casing may be required. However, the final dimensions of the drilled shaft shall not be altered to accommodate these construction practices unless approved by the Engineer. The Contractor shall take whatever steps are required to prevent caving during shaft excavation including installation of deeper casings. If the Contractor elects to remove a casing and replace it with a longer casing through caving soils, the Contractor shall adequately stabilize the excavation with slurry or backfill the excavation. Other approved methods which will control the size of the excavation and protect the integrity of the foundation soils may be used to excavate through caving layers.

803.03.2.3.5--Permanent Casing Method. The permanent casing method shall be used when required by the plans. In this method, a casing is driven to the prescribed depth before excavation begins. If full penetration cannot be attained, the Contractor may excavate material from inside the casing and the casing may be driven again until reaching the desired penetration. In some cases overreaming to the outside diameter of the casing may be required before driving the casing.

The casing shall be cut off at the prescribed elevation upon reaching the proper construction sequence, and the remainder of the casing is left in place.

803.03.2.3.6--Excavation and Drilling Equipment. The excavation and drilling equipment shall have adequate capacity including power, torque, and down thrust to excavate a hole of both the maximum diameter and to a depth 20 percent greater than the longest shaft shown on the plans.

The excavation and overreaming tools shall be of adequate design, size, and strength to perform the work shown on the plans or described herein. When the material encountered cannot be drilled using conventional earth augers with soil or rock teeth, drill buckets, and/or underreaming tools, the Contractor shall provide special drilling equipment including but not limited to: rock core barrels, rock tools, air tools, blasting materials, and other equipment as necessary to construct the shaft excavation to size and depth required. Approval of the Engineer is required before excavation by blasting is permitted.

Sidewall overreaming shall be required when the sidewall of the hole is determined by the Engineer to have either softened due to excavation methods or delays in excavation completion, swelled due to delays in concreting, or degraded because of slurry cake build-up. Overreaming thickness shall be a minimum of 1/2 inch and a maximum of three inches beyond the shaft radius. Overreaming may be accomplished with a grooving tool, overreaming bucket, or other approved equipment. The thickness and elevation of sidewall overreaming shall be as directed by the Engineer. The Contractor shall bear all costs associated with both sidewall overreaming and additional shaft concrete placement.

803.03.2.3.7--Excavations.

803.03.2.3.7.1--General. Shaft excavations shall be made at locations and to the top of shaft elevations, estimated bottom of shaft elevations, shaft geometry and dimensions shown in the plans. The Contractor shall extend drilled shaft tip elevations when the Geotechnical Engineer determines that the material encountered during excavation is unsuitable and/or differs from that anticipated in the design of the drilled shaft.

The Contractor shall maintain a drilling log during shaft excavation. The log shall contain information such as: the description and approximate top and bottom elevation of each soil or rock strata, seepage or groundwater, and remarks. Three (3) copies of the final Contractor's log shall be furnished to the Engineer with a copy to the Geotechnical Engineer at the time the drilled shaft is completed and accepted.

When shown on the plans, bells shall be excavated to form the height and bearing area of the size and shape shown. The bell shall be excavated by mechanical

methods. Any drilled shaft concrete over the theoretical amount required to fill any excavations for the bells and shafts dimensioned on the plans shall be furnished at no additional cost to the State.

The Contractor shall not permit workmen to enter a shaft excavation for any reason unless: both a suitable size casing has been installed and the water level has been lowered and stabilized below the level to be occupied, and adequate safety equipment and procedures have been provided to workmen entering the excavation. The Contractor is responsible for complying with all State and Federal safety regulations.

803.03.2.3.7.2--Obstructions. Surface and subsurface obstructions at drilled shaft locations shall be removed by the Contractor. Such obstructions may include man-made materials such as old concrete foundations, and natural materials such as boulders. Special procedures and/or tools shall be employed by the Contractor after the hole cannot be advanced using conventional augers fitted with soil or rock teeth, drilling buckets and/or underreaming tools. Such special procedures/tools may include but are not limited to: chisels, boulder breakers, core barrels, air tools, hand excavation, temporary casing, and increasing the hole diameter. Blasting shall not be permitted unless specifically approved in writing by the Engineer.

Drilling tools which are lost in the excavation shall be promptly removed by the Contractor at no cost to the State. All costs due to lost tool removal shall be borne by the Contractor including, but not limited to, costs associated with hole degradation due to removal operations or the time the hole remains open.

803.03.2.3.7.3--Exploration. When directed by the Engineer, the Contractor shall take soil samples or rock cores to determine the character of the material directly below the completed shaft excavation. The soil samples shall be extracted with a standard penetration test split spoon sampler or undisturbed sample (Shelby) tube. Rock cores, if required, shall be cut with an approved double or triple tube core barrel to a minimum of five (5) feet below the bottom of the drilled shaft excavation at the time the shaft excavation is approximately complete. Rock core, undisturbed tube, and/or standard penetration test samples shall be measured, visually identified, and described on the Contractor's log. The samples shall be placed in suitable containers, identified by shaft location, elevation, and project number, and delivered with the Contractor's field log to the Engineer within 24 hours after the exploration is completed. The Engineer will inspect the samples, or cores, and determine the final depth of required excavation based on the evaluation of the material.

803.03.2.3.7.4--Excavation Completion. Concrete placement must begin within two (2) hours of completion of shaft excavation. If the drilled shafts are five (5) feet in diameter or larger and in excess of sixty (60) feet in length, the elapsed time from completion of the drilled shaft excavation until beginning concrete

placement may extend past two hours provided the excavation remains stable and the extended time is demonstrated on the trial shaft. Completion of shaft excavation is defined as the time at which the specified tip elevation is initially achieved. Before concrete placement begins, bottom cleaning operations, any necessary slurry desanding, and placement of the reinforcing steel must be completed. These operations are included in the two hour time limit.

When it becomes apparent, as the excavation of the shaft is nearing completion, that it will not be feasible or possible to place concrete within the specified limit, the Contractor shall halt excavation operations a minimum of five (5) feet above the specified tip elevation. In the event that the wet construction method is being used, the slurry should be desanded at this point so that the remaining excavation will not cause the slurry to be too heavily contaminated and delay concrete placement due to final desanding operations.

In no case shall any excavation within the bearing zone(s) be allowed to remain open and idle for more than 24 hours. The bearing zone(s) are considered as those soil strata below the scour line, in the case of hydraulic structures, or those five feet below the ground line, whichever is greatest in depth. In no instance shall any uncased excavation, except for trial shafts, be allowed to remain open and idle for more than 24 hours. For partially completed excavations which stand idle for more than six (6) hours but less than 24 hours, sidewall overreaming may still be required by the Engineer.

If completion of shaft excavation has been achieved, and concrete placement has not begun within the specified limit, the Contractor shall backfill and/or stabilize the excavation. The Engineer shall then direct the Contractor as to the additional shaft excavation that will be required to produce a sound drilled shaft due to shaft wall and bottom degradation. The cost of the additional excavation, concrete, reinforcing steel, and other incidentals will be borne by the Contractor at no additional cost to the State.

803.03.2.3.7.5--Casings.

803.03.2.3.7.5.1--General. Casings shall be steel, smooth, clean, watertight, and of ample strength to withstand both handling and driving stresses and the pressure of both concrete and the surrounding earth materials. The outside diameter of casing shall not be less than the specified size of shaft. No extra compensation will be allowed for concrete required to fill an oversized casing or oversized excavations. All casings, except permanent casing, shall be removed from the shaft excavation. Any length of permanent casing installed below the shaft cutoff elevations shall remain in place.

When the shaft is to extend above the ground or through a body of water, the portion exposed above the ground or through a body of water may be formed with removable casing, except when permanent casing is specified. Removable

casing shall be stripped from the shaft in a manner that will not damage the concrete. Casings can be removed when the concrete is cured for a full 72 hours; the shaft concrete is not exposed to salt water or moving water for seven (7) days; and the concrete reaches a compressive strength of at least 2500 psi as determined from concrete cylinder tests.

803.03.2.3.7.5.2--Temporary Casing. All subsurface casing shall be considered temporary unless specifically shown as permanent in the contract documents. All temporary casing shall be removed. Telescoping, predrilling with slurry, and/or overreaming to beyond the outside diameter of the casing may be required to install the casing. When temporary casing larger than called for on the plans is used for telescoping or overreaming, no additional compensation will be made.

If the Contractor elects to remove a casing and substitute a longer or larger diameter casing through caving soils, the excavation shall be either stabilized with slurry or backfilled before the new casing is installed, as directed in Subsection 803.03.5.4. Other methods, as approved by the Engineer, may be used to control the stability of the excavation and protect the integrity of the foundation soils.

When temporary casings which are to be removed become fouled or bound in the shaft excavation and cannot be practically removed, and concreting has not yet begun, the Engineer may direct that the shaft excavation be drilled deeper to compensate for the loss of capacity due to the presence of the casing. No additional compensation will be paid for the casing left in the excavation. No additional length of shaft will be paid for beyond the current depth of excavation or the plan tip elevation of the production shaft, whichever is lower.

Temporary casings which become bound or fouled during concreting of the shaft, and cannot be practically removed before the concrete begins to set up, shall constitute a defect in the drilled shaft. When the Engineer, in writing, notifies the Contractor of a defective shaft, the Contractor shall be responsible for improving such defective shafts to the satisfaction of the Engineer. Improvements may consist of, but are not limited to, removing the shaft concrete and extending the shaft deeper to compensate for loss of frictional capacity in the cased zone, providing straddle shafts to compensate for capacity loss, proof load testing or providing replacement shafts. All corrective measures, including redesign of footings or drilled shaft caps, shall be performed to the satisfaction of the Engineer by the Contractor without either additional compensation or extension of Contract Time. No compensation will be paid for casing remaining in place. Any redesigns submitted must be approved in writing by the Bridge Engineer.

Temporary casing extraction shall be slow and uniform, pulling along the axis of the shaft. The elevation of the concrete in the casing shall be maintained high enough to displace the drilling slurry between the outside of the casing and the edge of the hole as the casing is removed. Temporary casings shall be removed

while the concrete remains workable. No temporary casings will be removed if the concrete slump is less than four (4) inches. Should this condition occur, the shaft will be designated as defective, and corrections to the situation shall be as described above.

Special casing systems may be used in open water areas, when approved, which are designed to permit removal after the concrete has hardened. Special casings shall be designed so that no damage occurs to the drilled shaft concrete during their removal. Any defects either cosmetic or structural that are apparent after removal of the casing or are due to the removal of the casing shall be repaired to the satisfaction of the Engineer at no additional cost to the State.

In the event that permanent casing is not specified in the plans, and the Contractor elects to use a temporary casing and leave it in place, it shall be cut off at a maximum of 12 inches above the low water elevation as shown on the plans, or painted. Written approval from the Engineer is required in this event, and payment for the temporary casing left in place will be at the contract bid price for temporary casing.

803.03.2.3.7.5.3--Permanent Casings. Permanent casing shall be used when shown on the plans. The casing shall be continuous between top and bottom elevations prescribed on the plans or as directed by the Engineer. Exterior surfaces of permanent casing shall be painted in accordance with the plans unless otherwise noted. After installation is complete, the permanent casing shall be cut off at the prescribed elevation and the shaft completed.

In general, permanent casing shall not be placed in an overreamed shaft hole.

803.03.2.3.8--Slurry. Mineral slurries shall be employed when slurry is used in the drilling process, unless other drilling fluids are approved in writing by the Engineer. The slurry shall have both a mineral grain size that will remain in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. The percentage and specific gravity of the material used to make the suspension shall be sufficient to maintain the stability of the excavation and to allow proper concrete placement. During construction, the level of the slurry shall be maintained at a height sufficient to prevent caving of the hole. In the event there is a sudden, significant loss of slurry within the drilled shaft excavation, the construction of the drilled shaft shall be stopped until a method to stop slurry loss or an alternate construction procedure has been approved by the Engineer.

Mineral slurry shall be premixed thoroughly with clean, fresh water, and an adequate time (as prescribed by the mineral manufacturer) shall be allotted for hydration, prior to introduction into the shaft excavation. Slurry tanks of adequate capacity will be required for slurry circulation, storage, and treatment. No excavated slurry pits will be allowed in lieu of slurry tanks, without the

written permission of the Engineer. Desanding equipment shall be provided by the Contractor as necessary to control slurry sand content to less than two percent (2%) by volume at any point in the borehole. Desanding will not be required for setting sign post or lighting mast foundations unless shown on the plans. The Contractor shall take all steps necessary to prevent the slurry from "setting up" in the shaft. Such methods may include, but are not limited to: agitation, circulation, and/or adjusting the properties of the slurry. Disposal of all slurry shall be performed offsite in suitable areas by the Contractor, and subject to all environmental regulations pertaining to slurry disposal.

Control tests using suitable apparatus shall be carried out on the mineral slurry mixture by a qualified individual or qualified professional testing laboratory approved by the Engineer. Tests to be conducted will be density, sand content, viscosity, and pH. The acceptable range of values for those physical properties is as shown in the following table:

MINERAL SLURRY
Sodium Montmorillonite (Commercial Bentonite)
Acceptable Range of Values

Property Units	At Time of Slurry Introduction	In Hole at Time of Concreting	Test Method
Density, pcf	64.3** - 69.1**	64.3** - 75.0**	Density Balance
Viscosity, seconds/quart	28 - 45	28 - 45	Marsh Cone
pH	8 - 11	8 - 11	pH paper pH meter

**Increase by 2 pcf in salt water

- Notes: a. Tests should be performed when the slurry temperature is above 40 degrees Fahrenheit.
- b. If desanding is required, sand content shall not exceed two percent (2%) by volume at any point in the borehole as determined by the American Petroleum Institute sand content test.

The limits in the above table may be adjusted when field conditions warrant, as successfully demonstrated on the trial shaft or as directed by the Engineer. All changes must be approved in writing by the Engineer before continued use.

Tests to determine density, viscosity, and pH value shall be performed during the shaft excavation to establish a consistent working pattern. A minimum of four (4) sets of tests shall be made during the first eight (8) hours of slurry use. When the results show consistent behavior, the testing frequency may be decreased to one set every four (4) hours of slurry use.

The Contractor shall insure that heavily contaminated slurry suspension, which could impair the free flow of concrete, has not accumulated in the bottom of the shaft. Prior to placing concrete in any shaft excavation, the Contractor shall take slurry samples using a sampling tool approved by the Engineer or similar to that shown in Figure 2. Slurry samples shall be extracted from the base of the shaft and at intervals not exceeding 10 feet up the shaft, until two consecutive samples produce acceptable values for density, viscosity, pH, and sand content.

When any slurry samples are found to be unacceptable, the Contractor shall take whatever action is necessary to bring the mineral slurry within specification requirements. Concrete shall not be poured until resampling and testing produce acceptable results.

Reports of all tests required above, signed by an authorized representative of the Contractor, shall be furnished to the Engineer on completion of each drilled shaft. Representatives of the Department may perform comparison tests as determined necessary during mineral slurry operations.

During construction, the level of mineral slurry in the shaft excavation shall be maintained at a level not less than four (4) feet above the highest expected piezometric pressure head along the depth of the shaft. If at any time the slurry construction method fails to produce the desired final results, the Contractor shall discontinue this method and propose an alternate method for approval by the Engineer.

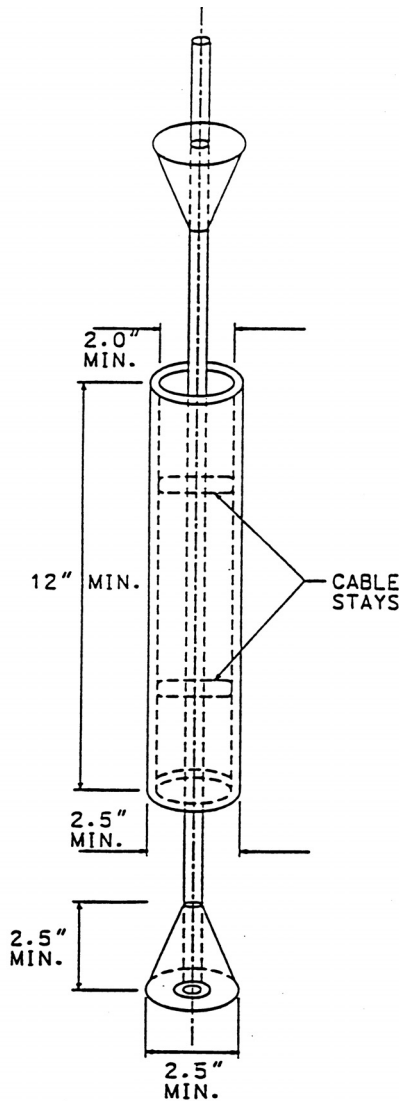
Drilling tools should contain vents to stabilize hydrostatic pressure above and below the tool during extraction. The rate of tool extraction should not cause any noticeable turbulence in the hole.

In locations where saline or chemically contaminated groundwater exists, the slurry should be adjusted with appropriate chemical additives, or developed with a mineral material not affected by such conditions.

803.03.2.4--Excavation Inspection. The Contractor shall provide equipment for checking the dimensions and alignment of each drilled shaft excavation. The dimensions and alignment shall be determined by the Contractor in the presence of the Engineer or the Engineer's inspector. Final shaft depths shall be measured with a weighted tape or other approved methods after final cleaning. Unless otherwise stated on the plans, a minimum of 50 percent of the base of each shaft shall have less than 1/2 inch of sediment at the time of placement of the concrete.

Shaft cleanliness will be determined by the Engineer, by visual inspection for dry shafts, or other methods deemed appropriate to the Engineer for wet shafts. In addition, for dry excavations, the maximum depth of water shall not exceed three (3) inches prior to concrete pour.

SLURRY SAMPLER



The sampler consists of three components:

- 1. Cable with weighted cone-shaped stopper.
- 2. Cylindrical sampler center stayed for alignment.
- 3. Top stopper with hole drilled through the center.

SAMPLING PROCEDURE

- 1. Lower cable with stopper to desired sampling elevation.
- 2. Slide cable through aligning guides of sampler.
- 3. Let sampler drop down the cable and seat onto bottom cone-shaped stopper.
- 4. Slide cable through hole in top stopper and let drop to seat on top of sampler.
- 5. Withdraw entire assembly from shaft.
- 6. Sample may be emptied into separate container and used as necessary to perform required testing.

Figure 2

803.03.2.5--Construction Tolerances. The following construction tolerances apply to drilled shafts unless otherwise stated in the contract documents.

- 1) The drilled shaft shall be within three (3) inches of plan position in the horizontal plan at the plan elevation for the top of the shaft.
- 2) The vertical alignment of a vertical shaft excavation shall not vary from the plan alignment by more than 1/4 inch per foot of depth.
- 3) After all the concrete is placed, the top of the reinforcing steel cage shall be not more than three (3) inches below plan elevation.
- 4) All casing diameters shown on the plans refer to O.D. (outside diameter) dimensions. The dimensions of casings are subject to American Pipe Institute tolerances applicable to regular steel pipe. When approved, the Contractor may elect to provide a casing larger in diameter than shown on the plans.
- 5) Bells shall be excavated to the plan bearing area and height shown on the plans as a minimum. The actual diameter of the bells shall not exceed three (3) times the specified shaft diameter. All other plan dimensions shown for the bells may be varied, when approved, to accommodate the Contractor's equipment.
- 6) Top elevation of the shaft shall have a tolerance of plus one (1) inch or minus three (3) inches from the plan top of shaft elevation.
- 7) Excavation equipment and methods shall be designed so that the completed shaft excavation will have a planar bottom. The cutting edges of excavation equipment shall be normal to the vertical axis of the equipment within a tolerance of $\pm 3/8$ inch per foot of shaft diameter.

Drilled shaft excavations and completed shafts not constructed within the required tolerances are unacceptable. The Contractor shall be responsible for correcting all unacceptable shaft excavations and completed shafts to the satisfaction of the Engineer. Materials and work necessary, including engineering analysis and redesign, to complete corrections for out of tolerance drilled shaft excavations shall be furnished without either cost to the State or an extension of the completion dates of the project. Any redesign shall be performed by a professional engineer, registered in the State of Mississippi and engaged by the Contractor. Redesign drawings and computations prepared by the Contractor's engineer shall be signed and sealed.

Out of tolerance shaft holes shall be backfilled in an approved manner, when directed by the Engineer, until the redesign is complete and approved.

803.03.2.6--Reinforcing Steel Construction and Placement. The reinforcing steel cage, consisting of longitudinal bars, ties, cage stiffener bars, spacers, centralizers, and other necessary appurtenances, shall be completely assembled and placed as a unit immediately after the shaft excavation is inspected and accepted, and prior to concrete placement. Details of reinforcing steel will be as shown in the plans.

The reinforcing steel in the shaft shall be double-wire tied at all junctions and supported so that the reinforcing steel will remain within allowable tolerances given in Subsection 803.03.7. Stiff tie wire may be required for long reinforcing steel cages. Free-rolling concrete centralizers or other approved noncorrosive rolling centralizer devices shall be used at sufficient intervals. The centralizers shall be attached to the reinforcing steel cage near the bottom, and at intervals not exceeding 10 feet up the shaft for shaft lengths less than 60 feet, and intervals not exceeding seven (7) feet for shaft lengths greater than 60 feet, to insure concentric spacing for the entire cage length. Centralizers shall be constructed of approved material equal in quality and durability to the concrete specified for the shaft. The centralizers shall be of adequate dimension to insure a minimum five (5) inch annular space between the outside of the reinforcing cage and the side of the excavated hole. Approved cylindrical feet (bottom supports) shall be provided to insure that the bottom of the cage is maintained the proper distance above the base.

The elevation of the top of the steel cage shall be checked before and after the concrete is placed. If the rebar cage is not maintained within the specified tolerances, corrections shall be made by the Contractor to the satisfaction of the Engineer. No additional shafts shall be constructed until the Contractor has modified the rebar cage support in a manner satisfactory to the Engineer.

If the bottom of the excavated shaft elevation is lower than the bottom of the shaft elevation shown on the plans, all reinforcement required in the upper portion of the shaft shall be achieved by splicing the additional length at the bottom of the cage, to avoid congestion in the upper portion of the shaft.

803.03.2.7--Concrete Placement.

803.03.2.7.1--General. Drilled Shaft concrete shall meet the requirements in Section 804.

Concrete placement during cold weather shall be allowed when ambient air conditions are at or expected to drop below 40°F, but protection of the fresh concrete shall be in accordance with the provisions stated in Sections 804 and 501. The Contractor shall assume all responsibility for protection of fresh concrete in cold weather.

Concrete shall be placed as soon as possible after reinforcing steel placement. Concrete placement shall be continuous from the bottom to the top elevation of the shaft. Concrete placement shall continue after the shaft excavation is full until good quality concrete is evident at the top of the shaft. Concrete shall be placed either through a tremie, concrete pump or free fall. Free fall placement shall require prior written approval of the Engineer and shall be restricted for use in dry excavations only.

For tremied or pumped concrete, the elapsed time from the beginning of concrete placement in the shaft to the completion of the placement shall not exceed four (4) hours, except as noted below. Retarders and/or water reducers in the concrete mix shall be adjusted as approved for the conditions encountered on the job, so that the concrete remains in a workable plastic state throughout the four hour placement limit. This is defined as a minimum slump of four (4) inches existing everywhere within the concrete shaft after placement has been completed. Prior to concrete placement, the Contractor shall provide test results of a trial mix, set time test per AASHTO Designation: T 197, and a slump loss test using approved methods, to demonstrate that the concrete meets this four hour requirement. These tests shall be conducted by an approved testing laboratory at least 30 days prior to initial concrete placement, with the Department's Central Laboratory personnel present, at temperatures and conditions similar to those at the job site at the time of the shaft pour. However, the Contractor may request a longer placement time, provided a concrete mix is supplied that will maintain a slump of four (4) inches or greater over the longer placement time, as demonstrated by trial mix, set time, and slump loss tests. A slump loss test shall be conducted from the concrete at the site for verification of slump loss requirements, using a sample from a minimum batch size of four cubic yards of concrete.

In the event that free-fall concrete placement is approved and used, the four inch slump in four hours requirement will be waived. However, a different trial mix must be approved with its corresponding set time and slump loss tests.

The Contractor shall place the concrete within the approved time and temperature limitations determined by the trial mix demonstration.

Before the casing is withdrawn, the level of fresh concrete shall be at such a level that the fluid trapped behind the casing is displaced upward. As the casing is withdrawn, care shall be exercised to maintain the level of concrete within the casing so that the fluid trapped behind the casing is displaced upward out of the shaft excavation without mixing with or displacing the shaft concrete.

803.03.2.7.2--Tremies. Tremies used for concrete placement in either wet or dry excavations shall consist of a tube of sufficient length, weight, and diameter to discharge concrete at the shaft base elevation. The tremie shall not contain aluminum parts which will have contact with the concrete. The tremie inside diameter shall be at least six (6) times the maximum size of aggregate used in the concrete mix but shall not be less than 10 inches. The inside and outside surfaces of the tremie shall be clean and smooth to permit both flow of concrete and unimpeded withdrawal during concreting. The wall thickness of the tremie shall be adequate to prevent crimping or sharp bends which restrict concrete placement.

The tremie used for wet excavation concrete placement shall be watertight. Underwater placement shall not begin until the tremie is placed at the bottom of

the excavation. Valves, bottom plates, or plugs may be used only if concrete discharge can begin within one tremie diameter of the base. Plugs and plates shall either be removed from the excavation or be of a material, approved by the Engineer, which will not cause a defect in the shaft if not removed. The discharge end of the tremie shall be constructed to permit the free radial flow of concrete during placement operations. The tremie discharge end shall remain at the excavation bottom as long as possible, and thereafter be immersed at least two shaft diameters but not less than 10 feet in concrete at all times after starting the flow of concrete. The flow of concrete shall be continuous. The concrete in the tremie shall be maintained at a positive pressure differential at all times to prevent water or slurry intrusion into the shaft concrete.

If, at any time during the concrete pour in a wet excavation, the tremie line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete level, the shaft shall be considered defective. In such case, the Contractor shall remove the reinforcing cage and concrete, complete all necessary sidewall removal directed by the Engineer and repour the shaft. All costs of replacement of defective shafts shall be the responsibility of the Contractor.

803.03.2.7.3--Pumping Concrete. Concrete pumps and lines may be used for concrete placement in either wet or dry excavations. All pump lines shall have a minimum five (5) inch diameter and be constructed with watertight joints. The use of aluminum pipe as a conveyance for the concrete will not be permitted. Concrete placement shall not begin until the pump line discharge orifice is at the bottom of the excavation.

For wet excavations, a plug or similar device shall be used to separate the concrete from the fluid in the hole until pumping begins. The plug shall either be removed from the excavation or be of a material, approved by the Engineer, which will not cause a defect in the shaft if not removed.

The discharge orifice shall remain at least two shaft diameters but not less than 10 feet below the surface of the fluid concrete at all times after starting the flow of concrete. When lifting the pump line during concreting, the Contractor shall temporarily reduce the line pressure until the orifice has been repositioned at a higher level in the excavation.

If, at any time during the concrete pour, the pump line orifice is removed from the fluid concrete column and discharges concrete above the rising level, the shaft shall be considered defective. In such case, the Contractor shall remove the reinforcing cage and concrete, complete all necessary sidewall removal directed by the Engineer and repour the shaft. All costs of replacement of defective shafts shall be the responsibility of the Contractor.

803.03.2.7.4--Free Fall Method. Placement of concrete by the free fall method

will be permitted only when approved in writing by the Engineer. Approval of concrete placement by the free fall method shall be contingent upon the following conditions:

- 1) The clear opening inside the reinforcing cage is not less than 24 inches in diameter.
- 2) The dry construction method is used in constructing the drilled shafts.
- 3) The height of free fall placement shall not exceed 75 feet.
- 4) Concrete shall fall directly to the placement location without contacting either the reinforcing cage or shaft walls.
- 5) A hopper shall be used at the top of the shaft to center and direct free fall placement.
- 6) The Engineer will observe the falling of the concrete within the shaft. The Contractor shall reduce the rate of concrete placement or reduce the height of free fall as directed by the Engineer when the concrete strikes the reinforcing cage or shaft sidewalls, when there is excessive spatter from the impact of the falling concrete, or when concrete placement causes the shaft excavation to cave or slough.
- 7) When in the opinion of the Engineer, placement cannot be satisfactorily accomplished by the free fall method, the Contractor shall change to either the tremie or pumping method to accomplish the pour.

803.03.2.8--Drilled Shaft Load Tests. The methods required for the load testing of drilled shafts shall be Static and/or Static with Special Instrumentation. Load testing of drilled shafts shall be completed before construction of any production drilled shafts, and the results used by the Bridge Engineer to determine the drilled shaft lengths given on the order list. The method, number, and locations of load tests shall be as shown on the plans or as designated by the Engineer.

After completion of any load test, the order list providing the final production lengths will be provided within two weeks of receiving the load test results. The production shaft lengths provided by the Bridge Engineer may differ from the individual shaft lengths shown on the plans. Requests for adjustment to the contract due to changes in shaft lengths shall be subject to the provisions of Subsection 104.02.1. Before any consideration will be given for an adjustment to the contract, it must be determined that a significant change in the character of the work has occurred.

803.03.2.8.1--Static Load Tests. Static load testing shall not begin until the concrete has attained a compressive strength of 3000 psi as determined from

cylinder tests. During the curing time, no other construction or operations which will induce excessive vibration levels, as previously discussed, shall be performed.

Static axial load tests shall be performed by personnel of the Geotechnical Branch of MDOT assisted by the Contractor's personnel using the procedures as described in ASTM Designation: D 1143, quick test method. No weighted platforms to totally supply the axial load are allowed.

The Contractor shall be responsible for furnishing the following:

- 1) A reaction frame capable of resisting a total load of at least four (4) times the design load of the test shaft shall be provided. The frame shall consist of a beam(s) or girder(s) that will carry the required load while sustaining only minor deflections in the reaction system. The beam or girder shall be attached to a system of anchor shafts or piles. The anchor piles shall not be closer than three (3) diameters measured from the center of the test shaft.
- 2) A hydraulic jack that has been calibrated for the full range of anticipated loads in accordance with AASHTO Designation: T 67 (ASTM Designation: E 4) at least once. The maximum anticipated load shall be assumed to be four (4) times the design load for the test shaft. The pressure gauge shall be calibrated within one year preceding time of use. The Contractor shall furnish a certificate of calibration for the hydraulic jack at the time of load testing.
- 3) A measuring frame or reference beam for measuring the movement of the test shaft during testing. Two dial gauges, supplied by the Department, will be attached to the test shaft during testing to monitor downward movement. Each dial gauge will be actuated by its stem or by a stem attachment resting on the measuring frame. The supports for the measuring frame shall be placed the maximum practical distance from the test pile and the anchor shafts or piles. In no case shall the measuring frame be affected by movement of the test shaft or the anchor shafts or piles.

The Geotechnical Branch will furnish the load cell, gages, any needed details of the shaft gauge locations and personnel to run the test. The Geotechnical Branch shall also be responsible for reviewing and submitting the results to the Bridge Engineer. The Contractor shall submit a detailed plan for any jacks and load frame to the Engineer for evaluation. This plan should include the following:

- 1) Size and type of the reaction beam or beams.
- 2) Size, type, number, and length of reaction piles or shafts.

- 3) Type and capacity of any jacks and their most recent calibration documents.
- 4) A plan sheet shop drawing showing plan and profile of load frame details. Details should be shown for of how the reaction beam will be connected to the reaction piles or shafts. A detail showing how the jack, load cell (6" height, 11" diameter, supplied by MDOT), and bearing plates are to be arranged between the shaft top and the bottom of the reaction beam.
- 5) Details of a protected work area, including provisions such as a tent or shed for protection from inclement weather for the testing equipment, of a size and type required by the Engineer.

After testing is completed, the test shafts and any anchor shafts shall be cut off at an elevation two (2) feet below the finished ground surface. The portion of the shafts cut off and removed shall remain the property of the Contractor.

803.03.2.8.2--Load Testing of Drilled Shafts With Special Instrumentation.

803.03.2.8.2.1--General. When designated on the plans, a dedicated test shaft shall be constructed as detailed in the plans with instrumentation and hydraulic jack(s) cast in the concrete of the drilled shaft. The Contractor will be required to furnish all materials, equipment, labor, and incidentals necessary for conducting the load test and reporting the results. The Contractor shall subcontract the instrumenting, conducting, and reporting of the load test to the company supplying the instrumentation with the cost included in prices bid for test shaft.

No reaction systems and extra drilled shaft installations such as anchor shafts are required for conducting the load test. The load test is a non-destructive test, and if the test shaft designated on the plans is a production shaft, it shall be left in a condition suitable for use as a production shaft in the finished structure.

803.03.2.8.2.2--Materials. When called for in the plans, instrumentation shall be supplied to meet the requirements set forth in the plans. Instrumentation required in the plans are subject to prior approval by the State Geotechnical Engineer. Additional equipment that may be required is as follows.

- 1) Materials sufficient to construct a stable reference beam system for monitoring deflection of the shaft during testing, supported at a minimum distance of three (3) diameters from the center of the shaft to prevent disturbance of the reference system.
- 2) Materials sufficient to construct a protected work area, including provisions such as a tent or shed for protection from inclement weather for the load test equipment, of size and type required by the Engineer.

Materials supplied which do not become a part of a finished structure shall be removed from the job site at the conclusion of the load test.

803.03.2.8.2.3--Equipment. The Contractor shall supply any additional equipment required to install the testing instrumentation and conduct the load test, remove the load test apparatus, and, if the test shaft is to become a production shaft at the conclusion of the test, restore the shaft to a condition suitable for use in the finished structure. This equipment includes, but is not limited to:

- 1) Electric power and welding equipment, as required, to assemble the test equipment, instrumentation, and prepare the work area.
- 2) A suitable pressurized gas source consisting either of an approved air compressor or of compressed nitrogen, i.e. four 230 cubic-foot cylinders of nitrogen per load test.
- 3) Equipment and operators for handling the instrumentation and reinforcing cage, if required, during the installation of the test shaft and during the test. This shall include, but is not limited to, a crane or other lifting device, manual labor, and hand tools.
- 4) Equipment and labor sufficient to erect the protected work area and monitoring reference beam system, to be constructed to the requirements of the Engineer and instrumentation supplier.
- 5) Approved small piston type power grout pump with experienced operator, for grouting the cell upon completion of the test if required. Successful demonstration that the grout pumping system works as intended will be required before placing the instrumentation in the test shaft hole.
- 6) Approved small power mortar mixer with suitable mortar box to discharge grout, if required, with an experienced operator.
- 7) Screen with an approximately 1/4-inch mesh to screen grout prior to placement in the grout pump to prevent clogging of the grout pump or the piping.
- 8) Suitable operating and reference level platforms, as required by the Engineer and/or instrumentation supplier, for testing over water or in otherwise unstable foundation conditions.

803.03.2.8.2.4--Procedure. The test shaft shall be constructed by the shaft construction technique approved by the Engineer after trial shaft construction. The test shaft shall then be constructed in accordance with the plans and at the direction of the Engineer.

The instrumentation shall be assembled and made ready for installation under the direction of the instrumentation supplier, in a suitable area, adjacent to the test shaft, to be provided by the Contractor. When a reinforcing cage is required for the test shaft, the instrumentation shall be placed as directed in the plans.

When the test shaft excavation has been completed and accepted by the Engineer, the Contractor shall then install the instrumentation and, if required, the reinforcing cage assembly in the test shaft under the direction of the Engineer. The Contractor shall use the utmost care in handling the reinforcing cage and test equipment assembly so as not to damage the instrumentation during installation.

After the installation of the instrumentation, the test shaft shall be concreted in the manner approved from the trial shaft construction. Load testing shall not begin until the concrete has attained a compressive strength of 3000 psi as determined from cylinder tests. During the curing period, no other construction or operations which will induce excessive vibration levels shall be performed.

After completion of the load test, and at the direction of the Engineer, the Contractor shall remove any equipment, material, etc. which are not to be a part of the finished structure.

The Contractor shall supply the Engineer with six (6) copies of the final load test report.

803.04--Method of Measurement.

803.04.1--Test Piles. Test piles will be measured per each complete-in-place. Piles measured as test piles will not be included in the measurement of pay footage for permanent piles.

Test piles constructed in accordance with the lengths indicated on the plans and which are required to be extended or built up will be measured as a percentage, calculated by dividing the sum of the plan length plus the length of the ordered extension or build-up, by the plan length. Splices required for the extension(s) will not be measured for payment.

No measurement for payment will be made for cut-off of a test pile.

803.04.2--Conventional Static Pile Load Tests. Conventional static pile load tests will be measured by the actual number of static load tests conducted on either a test pile or permanent production pile in accordance with these specifications.

In the event a pile is reloaded in accordance with these specifications, the reloading will be measured for payment as 50 percent of a separate conventional static pile load test.

803.04.3--Pile Shoes. Pile shoes of approved design, ordered and used, will be measured and paid as set out in Subsection 803.05.3.

803.04.4--Piling. Piling, exclusive of those measured as test piles, will be measured by the linear foot for each class and size of piling furnished and installed in accordance with lengths shown on the plans or approved by the Bridge Engineer. Cut-offs for each individual pile will be measured and deducted as set forth in Subsection 803.04.5.

Pile lengths in excess of those shown on the plans or approved by the Bridge Engineer will not be measured for payment unless such additional lengths below cut-off are approved in writing by the Bridge Engineer for incorporation in the structure.

803.04.5--Cut-Off. The summation of all cut-offs shall be deducted at 40 percent to determine the length for payment of in-place permanent piling.

The summation of all cut-offs for pile lengths in excess of those shown on the plans or approved by the Bridge Engineer will be deducted at 100 percent to determine the length for payment of in-place permanent piling.

An allowance will be made for prestressed concrete piling cut-offs in accordance with the provisions of Subsection 803.05.5. Cut-offs shall be measured for payment per each for each pile requiring cut-off.

All piling cut-offs shall become the property of and shall be disposed of by the Contractor.

803.04.6--Extensions or Build-Ups. Extensions or build-ups will not be measured for payment as such, but will be included in the length of piling remaining in the finished structure. In determining the amount to be included in piling footage, no allowance will be made for cut-offs necessary to accomplish the extensions or build-ups.

803.04.7--Falsework and Defective Piles. No allowance will be made for furnishing or driving of falsework piles, for piles driven out of place, for defective piles, or for piles which are damaged by handling or driving.

803.04.8--Splices. Splices necessary for extensions or build-ups on bearing piles will be measured by the linear foot. For prestressed concrete piles, the number of linear feet will be determined by allowing seven linear feet of piling for each splice. For other piles, the number of linear feet will be determined by allowing four linear feet of piling for each splice. The total number of linear feet of piling to be paid for shall be determined by adding seven feet or four feet, as applicable, to the net length of piling for each splice in place in the finished structure.

No measurement or payment will be made for splices except those made at the direction and under the supervision of the Engineer.

803.04.9--Pre-formed Pile Holes. Pre-formed pile holes, when included as a pay item on the plans, will be measured by the linear foot. For trestle type bents, the footage for each hole will be determined by subtracting the elevation of the bottom of the hole shown on the itemized list from the elevation of the natural ground at the pile site or from the elevation of the excavated section, whichever is lower. For foundations and end bents, the footage will be determined by subtracting the elevation of the bottom of the hole as shown on the itemized list from the elevation of the bottom of the footing or the bottom of the end bent caps, as applicable.

803.04.10--PDA Test Piles, Special Instrumentation Load Test. PDA test piles, special instrumentation load test will be measured per each, which shall include a static load test with special instrumentation. Piles paid for as PDA test piles, special instrumentation load test, will not be included in the measurement of pay lengths for permanent piles.

Completion of this pay item shall include the 1-day restrike after the initial pile driving, the special instrumentation load test, and the restrike within 24 hours after the static load test and the individual components will not be considered separately. Any additional restrike required by the Engineer on this type test pile will be paid for as a PDA Restrike.

803.04.11--PDA Test Piles, Conventional Load Test. PDA test piles, conventional load test, will be measured per each, which shall include a static load test. Piles paid for as PDA test piles, conventional load test will not be included in the measurement of pay lengths for permanent piles.

Completion of this pay item shall include the 1-day restrike after the initial pile driving, the conventional static load test, and the restrike within 24 hours after the static load test and the individual components will not be considered separately. Any additional restrike required by the Engineer on this type test pile will be paid for as a PDA Restrike.

803.04.12--PDA Test Pile. PDA test pile will be measured per each. Piles paid for as PDA test piles will not be included in the measurement of pay lengths for permanent piles.

Completion of this pay item shall include the 1-day and 7-day restrike after initial driving and individual components will not be considered separately. Any additional restrike required by the Engineer on this type test pile will be paid for as a PDA restrike.

803.04.13--Pile Restrike. Pile restrike will be measured per each actually performed on permanent piles or test piles as directed by the Engineer. The pile restrike will be conducted as directed by the Engineer for bearing determination and may be conducted either with or without PDA monitoring.

803.04.14--Drilled Shaft. Drill shaft will be measured per linear foot. Measurement shall be the authorized length in feet of the completed concrete drilled shaft, including bells, of the diameter and containing the reinforcement shown on the plans. The length shall be determined as the difference between the plan top of shaft elevation and the final bottom of shaft elevation.

803.04.15--Test Shaft. Test shaft of the specified diameter will be measured per each. Such measurement shall be full compensation for excavating the test shaft through whatever materials are encountered to the bottom of the shaft elevation shown on the plans or as authorized by the Engineer, concrete, reinforcement, required casings, special instrumentation load cell when required, conducting and reporting load test results, restoring the site as required, and all other expenses to complete the work.

803.04.16--Trial Shaft. Trial shaft of the specified diameter will be measured per linear foot. Such measurement shall be full compensation for excavating the trial shaft hole through whatever materials are encountered to the bottom of shaft elevation shown on the plans or as authorized by the Engineer, using mineral slurry as necessary, utilizing temporary casing as necessary which is not a separate pay item, providing inspection facilities, backfilling the holes, setting reinforcement and placing concrete as required, restoring the site, and all other expenses necessary to complete the work.

803.04.17--Exploration. Exploration will be measured per linear foot of soil samples and/or rock cores of the diameter and length required and authorized by the Engineer. Such measurement shall be full compensation for drilling, extracting, packaging and classifying the samples or cores, delivering them to the Department, furnishing concrete to fill the core hole, and all other expenses necessary to complete the work.

803.04.18--Casing. Casing shall be measured per linear foot. Such measurement shall be full compensation for furnishing, placing, and removing when required, the casing in the shaft excavation.

803.05--Basis of Payment.

803.05.1--Test Piles. Test piles, measured as prescribed above, will be paid for at the contract unit price per each.

803.05.2--Conventional Static Pile Load Tests. Conventional static pile load tests, measured as prescribed above, will be paid for at the contract unit price per each.

803.05.3--Pile Shoes. If not covered by a contract item or otherwise required by the plans, metal shoes ordered by the Engineer will be paid for at double the invoice cost of the shoe. The cost of placing the pile shoes and driving piling with these additional requirements will not be paid for directly, and the cost thereof shall be considered incidental to the respective pile driving pay item.

803.05.4--Piling. Piling of the type specified will be paid for at the contract unit price per linear foot.

803.05.5--Cut-Offs. For permanent prestressed concrete piles required to be cut off and the cut-offs are not necessitated by damage to the pile or as a result of a pile furnished in a length greater than that established by the pile list on the plans or furnished by the Bridge Engineer, the Contractor will be paid \$60.00 per each pile cut-off for sizes smaller than 20 inches and \$80.00 per each pile cut-off for sizes 20 inches and larger.

803.05.6--Extensions or Build-Ups. Extensions or Build-ups will not be paid for directly, but will be included in payment for piling. No payment will be made for extensions or build-ups for test piles.

803.05.7--Blank.

803.05.8--Splices. Splices, measured as prescribed above, will be paid for at the contract unit price per linear foot for the particular type pile splices.

803.05.9--Pre-formed Pile Holes. Pre-formed pile holes of the sizes specified will be paid for at the contract unit price per linear foot.

803.05.10--PDA Test Piles, Special Instrumentation Load Test. PDA test piles, special instrumentation load test, measured as prescribed above, will be paid for at the contract unit price per each.

803.05.11--PDA Test Piles, Conventional Load Test. PDA test piles, conventional load test, measured as prescribed above, will be paid for at the contract unit price per each.

803.05.12--PDA Test Piles. PDA test piles, measured as prescribed above, will be paid for at the contract unit price per each.

803.05.13--Pile Restrike. Pile restrikes, measured as prescribed above, will be paid for at the contract unit price per each.

803.05.14--Drilled Shafts. Drilled shafts of the type specified, measured as prescribed above, will be paid for at the contract unit price per linear foot, which price shall include the cost of concrete, reinforcing steel, and all labor, materials including mineral slurry, equipment, and incidentals necessary to complete the drilled shaft.

803.05.15--Test Shafts. Test shafts of the type specified, measured as prescribed above, will be paid for at the contract unit price per each, which price shall be full compensation for excavating the test shaft through whatever materials are encountered to the bottom of the shaft elevation shown on the plans or as authorized by the Engineer, concrete, reinforcement, required casings, special instrumentation load cell if required, conducting and reporting load test results, restoring the site as required, and all other expenses to complete the work.

803.05.16--Trial Shaft. Trial shafts of the type specified, measured as prescribed above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for excavating the trial shaft through whatever materials are encountered to the bottom of the shaft elevation shown on the plans or as authorized by the Engineer, concrete, reinforcement, required casings, special instrumentation if required, conducting and reporting load test results, restoring the site as required, and all other expenses to complete the work.

803.05.17--Exploration. Exploration, measured as prescribed above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for drilling, extracting, packaging and classifying the samples or cores, delivering them to the Department, furnishing concrete to fill the core hole, and all other expenses necessary to complete the work.

803.05.18--Casings. Casings, measured as prescribed above, will be paid for at the contract price per linear foot, which price shall be full compensation for furnishing, placing, and removing (when required) the casing in the shaft excavation.

The prices thus paid shall be full compensation for all materials, tools, equipment, labor, and incidentals required to complete work.

Payment will be made under:

- 803-A: Test Pile - per each
- 803-B: Conventional Static Pile Load Test - per each
- 803-C: ____” Prestressed Concrete Piling - per linear foot
- 803-D: ____ Steel Piling -per linear foot

Section 803	Section 803
803-E: Concrete Piling Cut-off, <u>Size</u>	- per each
803-F: ____” Pre-formed Pile Hole	- per linear foot
803-G: PDA Test Pile, Special Instrumentation Load Test	- per each
803-H: PDA Test Pile, Conventional Load Test	- per each
803-I: PDA Test Pile	- per each
803-J: Pile Restrike	- per each
803-K: Drilled Shaft, ____” Diameter	- per linear foot
803-L: Test Shaft, ____” Diameter	- per each
803-M: Trial Shaft, ____” Diameter	- per linear foot
803-N: Exploration	- per linear foot
803-O <u> </u> * Casing, ____” Diameter	- per linear foot
* Temporary or Permanent	

SECTION 804--CONCRETE BRIDGES AND STRUCTURES

804.01--Description. This work consists of constructing concrete bridges and structures in accordance with these specifications and in reasonably close conformity with the dimensions, designs, lines, and grades indicated on the plans or established.

Construction of box bridges shall be in accordance with Sections 601 and 602.

804.02--Materials.

804.02.1--General. Concrete produced and controlled from this specification shall be accepted upon proper certification of concrete production through an approved quality control program and verification by job site acceptance criteria. The Contractor shall develop and implement a quality control program that will be used to maintain the required properties of concrete. For large volume projects, 2000 cubic yards and more, quality control and acceptance shall be achieved through statistical evaluation of test results. For small volume projects of more than 200 but less than 2000 cubic yards, quality control and acceptance shall be achieved by individual test results. For projects less than or equal to 200 cubic yards, refer to the requirements of TMD-20-05-00-000 “Sampling and Testing of Small Quantities of Miscellaneous Materials”.

The materials for concrete bridges and structures, when sampled and tested in accordance with Subsection 700.03, shall meet the requirements of the following Subsections:

Portland Cement	701.01 and 701.02
Admixtures	713.02
Fly Ash	714.05
Water	714.01.1 and 714.01.2
Fine Aggregate	703.02
Coarse Aggregate	703.03
Curing Materials	713.01
Joint Materials	707.01, 707.02, and 707.07
Structural Steel Joints and Bearing Devices	717.01
Sheet Copper	716.07.2
Bronze Bearing Devices	716.06
Copper-Alloy Bearing Devices	716.07.1
Self-Lubricating Bearing Plates	716.08
Bearing Pads	714.10
Wire Rope or Wire Cable for Prestressed Concrete	700.01 and 711.03
Sprayed Finish for Concrete Surface	714.12
Reinforcing Steel	711.02

804.02.2--Use, Care and Handling. The use, care and handling of materials shall conform to the applicable requirements of Subsection 501.03.10 and the specific requirements of Subsections 804.02.4 and 804.02.5. Unless otherwise authorized, only fine aggregate or coarse aggregate of one type and from the same source shall be used in the construction of any one unit of a structure. Should the Contractor, with written permission of the Engineer, elect to substitute high early strength cement for cement of the type specified, the Contractor will not receive additional compensation for the substitution.

804.02.3--Sampling & Testing. Sampling and testing shall meet the requirements of these specifications.

804.02.4--Care and Storage of Concrete Aggregates. The handling and storage of aggregates shall be such as to prevent segregation or contamination with foreign materials. The Engineer may require that aggregates be stored on separate platforms at satisfactory locations.

When specified, coarse aggregates shall be separated into two or more sizes in order to secure greater uniformity of the concrete mixture. Different sizes of aggregate shall be stored in separate stock piles sufficiently removed from each other to prevent the material at the edges of the piles from becoming intermixed.

804.02.5--Storage of Cement. All cement shall be stored in suitable weather-proof buildings or bins. These buildings or bins shall be placed in locations

approved by the Engineer. Provision for storage shall be ample, and the shipments of cement as received shall be stored separately or other provisions made to the satisfaction of the Engineer for easy access for the identification, inspection, and sampling of each shipment as deemed desirable. Stored cement shall meet the test requirements at any time after storage when a retest is ordered by the Engineer.

On small jobs, open storage consisting of a raised platform and ample waterproof covering may be permitted by written authorization from the Engineer.

When specified, the Contractor shall keep accurate records of deliveries of cement and of its use in the work. Copies of these records shall be supplied in the form required by the Engineer.

804.02.6--Classification and Uses of Concrete. When a specific class of concrete is not specified on the plans or in the contract documents, the structure or parts thereof shall be constructed with the class of concrete as directed by the Engineer.

The classes and their uses are as follows:

- (1) Class AA - Concrete for bridge construction and concrete exposed to seawater.
- (2) Class A - Concrete for use where indicated.
- (3) Class B - General use, heavily reinforced sections, cast-in-place concrete piles, and conventional concrete piles.
- (4) Class C - Massive sections or lightly reinforced sections.
- (5) Class D - Massive unreinforced sections and riprap.
- (6) Class F - Concrete for prestressed members.
- (7) Class FX - Extra strength concrete for prestressed members, as shown on plans.
- (8) Class S - For all seal concrete deposited under water.
- (9) Class DS - Drilled Shaft Concrete

804.02.7--Composition of Concrete. The composition of concrete mixtures shall meet the requirements of these specifications.

804.02.8--Laboratory Accreditation. The Contractor shall be responsible for furnishing the laboratory used to perform concrete quality control tests. The laboratory may be the Contractor's facility, the concrete producer's facility, or a certified independent testing laboratory.

Only laboratories certified by the Mississippi Department of Transportation are qualified to perform material testing. Certification by AASHTO Accreditation Program (AAP) will be acceptable if the laboratory is listed in the latest AASHTO Accreditation Program publication and maintains accreditation to completion of concrete work.

The Contractor’s laboratory designated for quality control testing shall have equipment necessary to test aggregates and concrete for the test methods listed in Table 1.

Table 1

AASHTO: T 2	Sampling Aggregates
AASHTO: T 19	Bulk Density (“Unit Weight”) and Voids in Aggregates
AASHTO: T 22	Compressive Strength of Cylindrical Concrete Specimens
AASHTO: T 23	Making and Curing Concrete Test Specimens in the Field
AASHTO: T 27	Sieve Analysis of Fine and Coarse Aggregates
AASHTO: T 84	Specific Gravity and Absorption of Fine Aggregate
AASHTO: T 85	Specific Gravity and Absorption of Coarse Aggregate
AASHTO: T 119	Slump of Hydraulic Cement Concrete
AASHTO: T 121	Mass per Cubic Meter (Cubic Foot), Yield, and Air Content (Gravimetric) of Concrete
AASHTO: T 126	Making and Curing Concrete Test Specimens in the Laboratory
AASHTO: T 141	Sampling Freshly Mixed Concrete
AASHTO: T 152	Air Content of Freshly Mixed Concrete by Pressure Method *
AASHTO: T 196	Air Content of Freshly Mixed Concrete by the Volumetric Method *
AASHTO: T 231	Capping Cylindrical Concrete Specimens
AASHTO: T 248	Reducing Field Samples of Aggregate to Testing Size
AASHTO: T 255	Total Evaporable Moisture Content of Aggregate by Drying
ASTM: C 1064	Temperature of Freshly Mixed Portland Cement Concrete

* Equipment necessary for either pressure or volumetric air content.

Testing equipment shall have been inspected by the Department or through AAP. Testing equipment calibration files shall be made available upon request by the Department.

804.02.9--Testing Personnel. Technicians testing Portland cement concrete, for either acceptance or production control purposes, shall be certified by an accepted certification program. Recertification is required for each Class after five years. Certification requirements are listed in Table 2.

Table 2

Required Certification	Concrete Technician’s Tasks
MDOT Class I or ACI Grade I	Field Testing of Plastic Concrete, AASHTO Designation: T 23, T 119, T 121, T 141, T 152, T 196, and ASTM Designation: C 1064
MDOT Class II	Aggregate Sampling, Total Moisture, and Sieve Analysis, AASHTO Designation: T 2, T 27, T 248, T 255

MDOT Class III	Unit Weight and Voids of Aggregates, Specific Gravity*, Concrete Mix Design, Capping and Compressive Strength of Cylindrical Concrete Specimens*, AASHTO Designation: T 19, T 22, T 84, T 85, T 126, T 231

* Technicians performing specific gravity or compressive strength tests shall be either Certified Class III or may be supervised by a Certified Class III Technician. Also, technicians performing these tests are required to demonstrate the specific gravity and compressive strength tests during the inspection of laboratory equipment by the Central Laboratory.

804.02.10--Portland Cement Concrete Mix Design. At least 30 days prior to production of concrete, the Contractor shall submit to the Engineer proposed concrete mix designs complying with TMD 21-12-00-000. Materials shall be from approved sources meeting the requirements of the Standard Specifications. Proportions for the mix designs shall be for the class concrete required by the contract plans and shall meet the requirements of the “Master Proportion Table for Structural Concrete Design” listed in Table 3. The concrete producer shall assign a permanent unique mix number to each mix design. Each mix design shall be field verified as required in Subsection 804.02.10.3. Acceptable field verification data shall be required for final approval of a mix design. All concrete mix designs will be reviewed by the Central Laboratory prior to use. Concrete mix designs disapproved will be returned to the Contractor with a statement explaining the disapproval.

Table 3
MASTER PROPORTION TABLE FOR STRUCTURAL CONCRETE DESIGN

CLASS	COARSE AGGREGATE SIZE NO. *	MAXIMUM WATER/ CEMENTITIOUS ** RATIO	SPECIFIED COMPRESSIVE STRENGTH (f'c) psi	MAXIMUM SLUMP *** inches	TOTAL AIR CONTENT %
AA	57 or 67	0.45	4000	3	3.0 to 6.0
A	57 or 67	0.45	4000	3	3.0 to 6.0
B	57 or 67	0.50	3500	4	3.0 to 6.0
C	57 or 67	0.55	3000	4	3.0 to 6.0
D	57 or 67	0.70	2000	4	3.0 to 6.0
F	67	0.40	5000	3	****
FX	67	(As required by special provisions)		3	****
S	57 or 67	0.45	3000	8	3.0 to 6.0
DS	67	0.45	4000	*****	****

* Maximum size aggregate shall conform to the concrete mix design for the specified aggregate.

** Maximum replacement of Portland cement by weight is 25% for fly ash or 50% for ground granulated blast furnace slag. The addition of fly ash as a replacement for cement will not be permitted in Type IP blended hydraulic cement, portland cement combined with ground granulated blast furnace slag or Type III portland cement when specified in the contract.

- *** The slump may be increased up to 6 inches with an approved mid-range water reducer or up to 8 inches with an approved type F or G high range water reducer. A mid-range water reducer is classified as a water reducer that reduces the mix water a minimum of 8% when compared to a control mix with no admixtures. Minus slump requirements shall meet those set forth in Table 3 of AASHTO M157 specifications.
- **** No entrained air except for pilings exposed to seawater.
- ***** Class DS Concrete for drilled shafts shall have an 8 ± 1 -inch slump. In the event the free fall method of concrete placement is used, the slump shall be 6 ± 1 -inch. No fly ash, ground granulated blast furnace slag, or F or G high range water reducers allowed in drilled shaft concrete. A slump retention admixture is required.

Either Type A, D, F, G, or mid-range chemical admixture, shall be used in all classes of concrete, except as noted above for drilled shaft concrete. Any combinations of water reducing admixtures shall be approved by the Engineer before their use.

804.02.10.1--Proportioning of Portland Cement Concrete Mix Design. Proportioning of Portland cement concrete shall be based on an existing mix of which the producer has field experience and documentation or based on a recently batched laboratory mix tested according to the required specifications.

804.02.10.1.1--Proportioning on the Basis of Previous Field Experience of Trial Mixtures. Where a concrete production facility has a record, based on at least 10 consecutive strength tests within the past 12 months from a mixture not previously used on Department projects, the standard deviation shall be calculated. The record of tests from which the standard deviation is calculated shall:

- a) Represent similar materials and conditions to those expected. Changes in materials and proportions within the test record shall not have been more closely restricted than those for the proposed work.
- b) Represent concrete produced to meet a specified strength.
- c) Consist of 10 consecutive tests, average of two cylinders per test, tested at 28 days.

The standard deviation, s , shall be calculated as:

$$s = \left[\sum (X_i - \bar{X})^2 \div (N - 1) \right]^{1/2}$$

where:

X_i = the strength result of an individual test

$\bar{X}$ = the average of individual tests in the series
 N = number of tests in the series

When the concrete production facility does not have a record of tests for calculation of standard deviation, as required in the above formula, the requirements of Subsection 804.02.10.1.2 shall govern.

The required average compressive strength (f'_{cr}) used as the basis for selection of concrete proportions shall conform to the inequality listed below, while using a standard deviation, s , calculated as shown above.

$$\bar{X} \geq f'_{cr}$$

where:

$$f'_{cr} = f'_c + 1.43s$$

where:

f'_c = specified compressive strength of concrete, psi
 f'_{cr} = required average compressive strength of concrete, psi
 s = standard deviation, psi

1.43 represents the Lower Quality Index necessary to assure that 93% of compressive strength tests are above f'_c .

804.02.10.1.2--Proportioning on the Basis of Laboratory Trial Mixtures.

When an acceptable record of field test results is not available, concrete proportions shall be established based on laboratory trial mixtures meeting the following restrictions:

- a) The combination of materials shall be those intended for use in the proposed work.
- b) Trial mixtures having proportions and consistencies suitable for the proposed work shall be made using the ACI 211.1 as a guide to proportion the mix design.
- c) Trial mixtures shall be designed to produce a slump within $\pm 3/4$ in. of the maximum permitted, and for air-entrained concrete, 6.0 ± 0.5 percent total air content. The temperature of freshly mixed concrete in trial mixtures shall be reported.
- d) For each proposed mixture, at least three compressive test cylinders shall be made and cured in accordance with AASHTO Designation: T 126.

Each change of water-cement ratio shall be considered a new mixture. The cylinders shall be tested for strength in accordance with AASHTO Designation: T 22 and shall meet the required 28 day strength.

- e) The required average strength of laboratory trial mixes shall exceed f'_c by 1200 psi for concrete mix designs less than 5000 psi and by 1400 psi for concrete mix designs of 5000 psi or more.
- f) The laboratory trial batch mixtures shall have been made within the previous 12 months before being submitted for approval and shall not have been previously used on Department projects.

804.02.10.2--Documentation of Average Strength. Documentation that the proposed concrete proportions will produce an average strength equal to or greater than the required average shall consist of the strength test records from field tests or results from laboratory trial mixtures.

804.02.10.3--Field Verification of Concrete Mix Design. Concrete mix designs will only be tentatively approved pending field verification. Mix designs may be transferred to other projects without additional field verification testing, once the mix design has passed the field verification process.

The Contractor's Certified Quality Control Technicians shall test each concrete mix design upon the first placement of the mix. Aggregates and concrete tests during the first placement shall be as follows:

<u>Aggregates</u>	<u>Concrete</u>
Bulk Specific Gravity	Water Content
Moisture	Slump
Gradation	Air Content
	Unit Weight
	Yield

The mix shall be verified to yield within 2.0% of the correct volume when all the mix water is added to the batch, producing a slump within a minus 1½ inches tolerance, or minus 2½ inches with Type F or G chemical admixture, of the maximum permitted and total air content within a minus 1½ percent tolerance of the maximum allowable air content listed in Table 3 . The mix shall be adjusted and retested, if necessary, on subsequent placements until the above mentioned properties are met. If the requirements of yield, slump, or air are not met after three attempts, subsequent field verification testing shall not be permitted on Department projects, and the mix design shall not be used until the requirements listed above are met. Any mix design adjustments, changes in the mix proportions, are to be made by a Class III Certified Technician representing the Contractor. After the mix design has been verified and adjustments made, verification test results will be reviewed by the Engineer.

804.02.10.4--Adjustments of Mixtures Proportions. After ten compressive tests have been performed for which a standard deviation is calculated, the mix design may be adjusted provided the average strength ($\bar{X}$) complies with the inequality in Subsection 804.02.10.1.1 and the adjusted mix design satisfies the water/cementitious ratio requirement listed in Table 3. Any adjustments of the concrete mix design shall necessitate repeat of field verification procedure as described in Subsection 804.02.10.3 and approval by the Engineer.

804.02.11--Concrete Batch Plants. The concrete batch plant and assigned mixer trucks shall be on the list of approved concrete batch plants and mixer trucks. For large quantity projects the plant shall meet the requirements for an automatic system capable of recording batch weights. It shall also have automatically moisture compensation for the fine aggregate.

For small volume projects, the plant can be equipped for manual batching with a fine aggregate moisture meter visible to the plant operator.

The concrete batch plant shall have available adequate facilities to cool concrete during hot weather.

804.02.12--Contractor's Quality Control. The Contractor shall provide and maintain a quality control program that will provide reasonable assurance that all materials and products submitted to the Department for acceptance will conform to the contract requirements, whether manufactured or processed by the Contractor or procured from suppliers, subcontractors, or vendors.

The Contractor's Quality Control program shall implement the minimum quality control requirements shown in Table 4, "CONTRACTOR'S MINIMUM REQUIREMENTS FOR QUALITY CONTROL". The quality control activities shown in the table are considered to be normal activities necessary to control the production and placing of a given product or material at an acceptable quality level. To facilitate the Department's activities, all completed gradation samples shall be retained for a maximum of sixty (60) days by the Contractor until further disposition is designated by the Department.

The Contractor shall perform, or have performed, the inspections and tests required to substantiate product conformance to contract document requirements and shall also perform, or have performed, all inspections and tests otherwise required.

The Contractor's Quality Control program shall encompass the requirements of AASHTO Designation: M 157 into concrete production and control, equipment requirements, testing, and batch ticket information. The requirement of AASHTO Designation: M 157, Section 11.7 shall be followed except, on arrival to the job site, a maximum of 1½ gallons per cubic yard shall be allowed to be

added to bring the slump within the required limits. Water shall not be added at a later time.

The Contractor's quality control inspections and tests shall be documented and shall be available for review by the Engineer throughout the life of the contract.

As set out in these specifications, quality control sampling and testing performed by the Contractor will be used by the Department for determination of acceptability of the concrete.

The Contractor shall maintain standard equipment and qualified personnel as required to assure conformance to contract requirements.

804.02.12.1--Quality Control Plan. The Contractor shall prepare a Quality Control Plan which shall identify the personnel responsible for the Contractor's quality control including the company official who will act as liaison with Department personnel. The Quality Control Plan shall be submitted in writing to the Engineer for approval 30 days prior to the production of concrete.

The class(es) of concrete involved will be listed separately. If an existing mix design(s) is to be used, the mix design number(s) as previously approved shall be listed.

It is intended that sampling and testing be in accordance with standard methods and procedures, and that measuring and testing equipment be standard and properly calibrated. If alternative sampling methods and procedures, and inspection equipment are to be used, they shall be detailed in the Quality Control Plan.

804.02.12.1.1--Elements of Plan. The Plan shall address all elements that affect the quality of the structural concrete including, but not limited to, the following:

- 1) Stockpile Management
- 2) Procedures for Corrective Actions for Non Compliance of Specifications
- 3) Procedure for Controlling Concrete Temperatures

804.02.12.2--Personnel Requirements. The Contractor's Designated Certified Technician shall perform and use quality control tests and other quality control practices to assure that delivered materials and proportioning meet the requirements of the mix design including temperature, slump, air content, and strength and shall periodically inspect all equipment used in transporting, proportioning, and mixing.

The Contractor's Designated Technician shall periodically inspect all equipment used placing, consolidating, finishing, and curing to assure it is operating

properly and that placement, consolidation, finishing, and curing conform to the mix design and other contract requirements.

804.02.12.3--Documentation. The Contractor shall maintain adequate records of all inspections and tests. The records shall indicate the nature and number of observations made, the number and type of deficiencies found, date and time of samples taken, the quantities approved and rejected, and the nature of corrective action taken as appropriate. The Contractor's documentation procedures will be subject to approval of the Department prior to the start of the work and to compliance checks during the progress of the work.

All conforming and non-conforming inspections and test results shall be kept complete and shall be available at all times to the Department during the performance of the work. Forms shall be on a computer-acceptable medium. Batch tickets and gradation data shall be documented in accordance with Department requirements. Copies shall be submitted to the Department as the work progresses.

Test data for Portland cement concrete, including gradation, shall be charted in accordance with the applicable requirements.

The Contractor may use additional control charts as deemed appropriate. It is normally expected that testing and charting will be completed within 24 hours after sampling.

All charts and records documenting the Contractor's quality control inspections and tests shall become the property of the Department upon completion of the work.

804.02.12.4--Corrective Action. The Contractor shall take prompt action to correct conditions that have resulted, or could result, in the submission to the Department of materials and products that do not conform to the requirements of the contract documents. All corrective actions shall be documented.

804.02.12.5--Non-Conforming Materials. The Contractor shall establish and maintain an effective and positive system for controlling non-conforming material, including procedures for its identification, isolation and disposition. Reclaiming or reworking of non-conforming materials shall be in accordance with procedures acceptable to the Department.

All non-conforming materials and products shall be positively identified to prevent use, shipment, and intermingling with conforming materials and products. Holding areas, mutually agreeable to the Department and the Contractor, shall be provided by the Contractor.

TABLE 4
CONTRACTOR'S MINIMUM REQUIREMENTS FOR QUALITY CONTROL

Portland Cement Concrete		
Control Requirement	Frequency	AASHTO/ASTM Designation
A. PLANT AND TRUCKS 1. Mixer Blades 2. Scales a. Tared b. Calibrate c. Check Calibration 3. Gauges & Meters - Plant & Truck a. Calibrate b. Check Calibration 4. Admixture Dispenser a. Calibrate b. Check Operation & Calibration	Monthly Daily Every 6 months Weekly Every 6 months Weekly Every 6 months Daily	
B. AGGREGATES 1. Sampling 2. Fine Aggregate a. Gradation / FM b. Moisture c. Specific Gravity / Absorption 3. Coarse Aggregates a. Gradation / FM b. Moisture c. Specific Gravity / Absorption	250 yd ³ Concrete Check Meter Against Test Results Weekly 2500 yd ³ Concrete 250 yd ³ Concrete Minimum of once daily or more as needed to control production 2500 yd ³ Concrete	T 2 T 27 T 255 T 84 T 27 T 255 T 85
C. PLASTIC CONCRETE 1. Sampling 2. Air Content 3. Slump 4. Compressive Strength 5. Yield 6. Temperature	First load then one per 50 yd ³ First load then one per 50 yd ³ One set (two cylinders) for 0-100 yd ³ inclusive and one set for each additional 100 yd ³ or fraction thereof for each class concrete delivered and placed on a calendar day from a single supplier. A test shall be the average of two cylinders. Each 400 yd ³ With each sample	T 141 T 152 or T 196 T 119 T 22, T 23, T 231 T 121 C 1064

804.02.13--Quality Assurance Sampling and Testing. Quality Assurance (QA) inspection and testing will be provided by the Department to assure that the Contractor's Quality Control (QC) testing meets the requirements of these specifications.

Acceptance of the material is based on the inspection of the construction, monitoring of the Contractor's quality control program, QC test results, and the comparison of the QA test results with the QC test results. The Department may use the results of the Contractor's QC tests as a part of the acceptance procedures instead of the results of QA tests, provided:

- a) The Department's inspection and monitoring activities indicate that the Contractor is following the approved Quality Control program and, respectively,
- b) For aggregates, the results from the Contractor's QC and the Department's QA testing of aggregate gradations compare by both meeting the aggregate type's gradation requirements;
- c) For concrete, the Contractor's QC and Department's QA testing of concrete compressive strengths compare when using the data comparison computer program with an alpha value of 0.01 for large volume projects; or, strength comparisons are within 990 psi for small volume projects.

The minimum frequency for QA testing of aggregate and plastic concrete by the Department will follow the frequencies listed in Table 5, “DEPARTMENT’S MINIMUM REQUIREMENTS FOR QUALITY ASSURANCE”.

TABLE 5
DEPARTMENT’S MINIMUM REQUIREMENTS FOR QUALITY ASSURANCE

Quality Assurance Tests	Frequency	AASHTO/ASTM Designation
A. AGGREGATES		
1. Sampling		T 2
2. Fine Aggregate Gradation and FM	250 yd³ Concrete	T 27
3. Coarse Aggregates Gradation and FM	250 yd³ Concrete	T 27
B. PLASTIC CONCRETE		
1. Sampling		T 141
2. Air Content	Every 100 yd³	T 152 or T 196
3. Slump	Every 100 yd³	T 119
4. Compressive Strength	One set (two cylinders) for every 100 yd³ inclusive. A test shall be the average of two cylinders.	T 22, T 23, T 231
5. Temperature	With each sample	C 1064

Periodic inspection by the Department of the Contractor’s QC testing and production will continue through the duration of the project. Weekly reviews will be made of the Contractor’s QC records and charts.

For aggregates, comparison of data of the Contractor’s QC aggregate gradation test results to those of the Department’s QA aggregate gradation test results will be made monthly during concrete production periods according to Department Standard Operating Procedures. When it is determined that the Contractor’s QC test results of aggregate gradations are comparative to that of the Department’s QA test results, then the Department will use the Contractor’s QC results as a basis for acceptance of the aggregates and the Department’s QA testing frequency of aggregates may be reduced to a frequency of no less than three QA tests to every 10 QC tests. If the Contractor’s QC aggregate gradation test

results fail to compare to those of the Department's QA aggregate gradation test results, Department testing for aggregate gradations will revert to the frequency shown in Table 5 for aggregates until the Contractor's and Department's aggregate gradation test data compare.

For concrete compressive strength, comparison of data of the Contractor's QC compressive strength test results to those of the Department's QA compressive strength test results will be made monthly during concrete production periods according to Department Standard Operating Procedures. When it is determined that the Contractor's QC test results of concrete compressive strengths are comparative to that of the Department's QA test results, then the Department will use the Contractor's QC results as a basis for acceptance of the concrete and the Department's QA testing frequency of concrete compressive strengths may be reduced to a frequency of no less than three QA tests to every 10 QC tests. If the Contractor's QC compressive strength test results fail to compare to those of the Department's QA compressive strength test results, Department testing will revert to the frequency shown in Table 5 for plastic concrete until the Contractor's and Department's compressive strength test data compare.

804.02.13.1--Basis of Acceptance.

804.02.13.1.1--Slump. Slump of plastic concrete shall meet the requirements of Table 3: MASTER PROPORTION TABLE FOR STRUCTURAL CONCRETE DESIGN. A check test shall be made on another portion of the sample before rejection of any load.

804.02.13.1.2--Air. Total air content of concrete shall be within the specified range for the class of concrete listed in Table 3: MASTER PROPORTION TABLE FOR STRUCTURAL CONCRETE DESIGN. A check test shall be made on another portion of the sample before rejection of any load.

804.02.13.1.3--Yield. If the yield of the concrete mix design is more than plus or minus 3% of the designed volume, the mix shall be adjusted by a Class III Certified Technician representing the Contractor to yield the correct volume plus or minus three percent ($\pm 3\%$). If batching of the proportions of the mix design varies outside the batching tolerance range of the originally approved proportions by more than the tolerances allowed in Subsection 804.02.12.1, the new proportions shall be field verified per Subsection 804.02.10.3.

804.02.13.1.4--Temperature. Cold weather concreting shall follow the requirements of Subsection 804.03.16.1. Hot weather concreting shall follow the requirements of Subsection 804.03.16.2 with a maximum temperature of 95°F for Class DS concrete containing a slump retention admixture and for concrete mixes containing pozzolanic materials as a replacement of Portland cement. For other classes of concrete without pozzolanic materials, the maximum concrete

temperature shall be 90°F. Concrete with a temperature more than the maximum allowable temperature shall be rejected and not used in Department work.

804.02.13.1.5--Compressive Strength. Laboratory cured concrete compressive strength tests shall conform to the specified strength (f'_c) listed in the specifications. Concrete represented by compressive strength test below the specified strength (f'_c) may be removed and replaced by the Contractor. If the Contractor elects not to remove the material, it will be evaluated by the Department as to the adequacy for the use intended. All concrete evaluated as unsatisfactory for the intended use shall be removed and replaced by the Contractor at no additional cost to the Department. For concrete allowed to remain in place, reduction in payment will be as follows:

Large Volume Projects. When the evaluation indicates that the work may remain in place, a statistical analysis will be made of the QC and QA concrete test results. If this statistical analysis indicates at least 93% of the material would be expected to have a compressive strength equal to or greater than the specified strength (f'_c) and 99.87% of the material would be expected to have a compressive strength at least one standard deviation above the allowable design stress (f_c), the work will be accepted. If the statistical analysis indicates that either of the two criteria are not met, the Engineer will provide for an adjustment in pay as follows for the material represented by the test result.

Total Pay on Material in Question = Unit Price - (Unit Price x % Reduction)

$$\% \text{ Reduction} = \frac{(f'_c - X)}{f'_c - (f_c + s)} \times 100$$

where:

- f'_c = Specified 28-day compressive strength, psi
- X = Individual compressive strength below f'_c , psi
- s = standard deviation, psi*
- f_c = allowable design stress, psi

* Standard deviation used in the above reduction of pay formula shall be calculated from the applicable preceding compressive strengths test results plus the individual compressive strength below f'_c . If below f'_c strengths occur during the project's first ten compressive strength tests, the standard deviation shall be calculated from the first ten compressive strength tests results.

Small Volume Projects. When the evaluation indicates that the work may remain in place, a percent reduction in pay will be assessed based on a comparison of the deficient 28-day test result to the specified strength. The

Engineer will provide for an adjustment in pay as follows for the material represented by the test result.

Total Pay on Material in Question = Unit Price - (Unit Price x % Reduction)

$$\% \text{ Reduction} = \frac{(f'_c - X)}{f'_c} \times 100$$

where:

f'_c = Specified 28-day compressive strength, psi

X = Individual compressive strength below f'_c , psi

804.02.14--Dispute Resolution. Disputes over variations between Contractor's QC test results and the Department's QA test results shall be resolved at the lowest possible level. When there are significant discrepancies between the QC test results and the QA test results, the Contractor's Quality Control Manager, the Project Engineer, and/or the District Materials Engineer shall look for differences in the procedures, and correct the inappropriate procedure before requesting a third party resolution.

If the dispute cannot be resolved at the project or District level, the Department's Central Laboratory will serve as a third party to resolve the dispute. The Central Laboratory's decision shall be binding.

The Contractor shall be responsible for the cost associated with the third party resolution if the final decision is such that the Department's QA test results were correct. Likewise, the Department will be responsible for the cost when the final decision is such that the Contractor's QC test results were correct.

804.03--Construction Requirements.

804.03.1--Measurement of Materials.

804.03.1.1--General. The accuracy for measuring materials shall be in accordance with AASHTO Designation: M 157.

804.03.1.2--Measurement by Weighing. Except when otherwise specified or authorized, materials shall be measured by weighing. The apparatus provided for weighing materials shall be suitably designed and constructed for this purpose. Cement and aggregates shall be weighed separately. Cement in standard bags need not be weighed, but bulk cement shall be weighed. The mixing water shall be measured by volume or by weight. All measuring devices shall be subject to approval.

804.03.2--Blank.

804.03.3--Blank.

804.03.4--Hand Mixing. Hand mixing of concrete will not be allowed.

804.03.5--Delivery. The plant supplying concrete shall have sufficient capacity and transporting apparatus to insure continuous delivery at the rate required. The rate of delivery shall be such as to provide for the proper continuity in handling, placing, and furnishing of the concrete. The rate shall be such that the interval between batches shall not exceed 20 minutes. The methods of delivering and handling the concrete shall be that which will facilitate placing with minimum rehandling and without damage to the structure or the concrete.

804.03.6--Handling and Placing Concrete.

804.03.6.1--General. Prior to placing concrete, all reinforcement shall have been accurately placed in the position shown on the plans and fastened as set out in Section 805. All sawdust, chips, and other construction debris and extraneous matter shall have been removed from the interior of the forms. Temporary struts, braces, and stays holding the forms in correct shape and alignment shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the forms and shall not be buried in the concrete.

No concrete shall be placed until the forms and reinforcement have been inspected.

Except as provided for truck mixers and truck agitators, concrete shall be placed in the forms within 30 minutes after the time that the cement is first added to the mix.

Concrete shall be placed so as to avoid segregation of materials and displacement of reinforcement. The use of troughs, chutes, and pipes over 25 feet in length for gravity conveyance of concrete to the forms, will not be permitted except when authorized by the Engineer and subject to the production of quality concrete.

Only approved mechanical conveyors will be permitted.

Open troughs and chutes shall be metal or metal lined. The use of aluminum pipes, chutes, or other devices made of aluminum that come into direct contact with the concrete shall not be used. Where steep slopes are required, the chutes shall be equipped with baffles or be in short sections that change the direction of movement.

All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. Water used for flushing shall be discharged clear of the structure.

When placing operations involve dropping the concrete more than five feet, it shall be deposited through sheet metal or other approved pipes to prevent segregation and unnecessary splashing. The pipes shall be made in sections to permit discharging and raising as the placement progresses. A non-jointed pipe may be used if sufficient openings of the proper size are provided to allow for the flow of the concrete into the shaft. As far as practicable, the pipes shall be kept full of concrete during placing, and their ends shall be kept buried in the newly placed concrete.

Except as hereinafter provided, concrete shall be placed in horizontal layers not more than 12 inches thick. When, with the Engineer's approval, less than the complete length of a layer is placed in one operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and compacted before the preceding layer has taken its initial set and shall be compacted so as to avoid the formation of a construction joint with the preceding layer.

804.03.6.2--Consolidation. Concrete, during and immediately after depositing, shall be thoroughly consolidated by the use of approved mechanical vibrators and suitable spading tools. Hand spading alone will be permitted on small structural members such as railing and small culvert headwalls. Mechanical vibration of concrete shall be subject to the following:

- A. The vibration shall be internal unless special authorization of other methods is given by the Engineer or as provided herein.
- B. In general, vibrators shall be a type and design approved by the Engineer. They shall be capable of vibration frequencies of at least 4500 impulses per minute.
- C. The intensity of vibration shall be such as to visibly affect a mass of concrete of one inch slump over a radius of at least 18 inches.
- D. The Contractor shall provide sufficient vibrators to properly compact each batch immediately after it is placed in the forms.
- E. Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and embedded fixtures and into the corners and angles of the forms.

Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted into and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued so as to cause segregation. Vibration shall not be continued at any one point to the extent that localized areas of grout are formed.

Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

- F. Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have taken initial set. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms.
- G. Vibration shall be supplemented by spading as necessary to insure smooth surfaces and dense concrete along form surfaces, in corners, and in locations impossible to reach with vibrators.
- H. These provisions shall apply to the filler concrete for steel grid floors except that the vibrator shall be applied to the steel.
- I. These provisions shall apply to precast piling, concrete cribbing, and other precast members except that, if approved by the Engineer, the manufacturer's methods of vibrations may be used.

When hand spading is used for consolidation, a sufficient number of workmen with spading tools shall be provided. They will be required to flush a thin layer of mortar to all the surfaces and thoroughly and satisfactorily consolidate the concrete.

The entire operation of depositing and consolidating the concrete shall be conducted so that the concrete shall be smooth and dense and free from honeycomb or pockets of segregated aggregate.

804.03.6.3--Discontinuance of Placing. When placing is temporarily discontinued, the concrete, after becoming firm enough to retain its form, shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete. To avoid visible joints insofar as possible upon exposed faces, the top surface of the concrete adjacent to the forms shall be smoothed with a trowel. Where a "feather edge" might be produced at a construction joint, such as in the sloped top surface of a wing wall, an inset form work shall be used in the preceding layer to produce a blocked out portion that will provide an edge thickness of at least six inches in the succeeding layer. Work shall not be discontinued within 18 inches of the top of any face unless provision has been made for a coping less than 18 inches thick. In this case and if permitted by the Engineer, the construction joint may be made at the under side of the coping.

Immediately following the discontinuance of placing concrete, all accumulations of mortar splashed on the reinforcement and the surface of forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset

concrete. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to break or injure the concrete-steel bond at and near the surface of the concrete while cleaning the reinforcement. After initial set the forms shall not be jarred, and no strain shall be placed on the ends of projecting reinforcement until the concrete has sufficiently set to insure against any damage by such jarring or strain.

804.03.6.4--Placing Bridge Concrete. The method and sequence of placing concrete shall conform to the provisions and requirements set forth for the particular type of construction.

804.03.6.4.1--Foundations and Substructures. Concrete seals shall be placed in accordance with Subsection 804.03.9. All other concrete for foundations shall be poured in the dry unless otherwise stipulated or authorization is given in writing by the Engineer to do otherwise. Concrete shall not be placed in foundations until the foundation area has been inspected and approved.

Unless otherwise specified, the placement of concrete in the substructure shall be in accordance with the general requirements of Subsection 804.03.6.

Unless otherwise directed, concrete in columns shall be placed in one continuous operation, and shall be allowed to set at least 12 hours before the caps are placed.

804.03.6.4.2--Superstructure. For simple spans, concrete shall preferably be deposited by beginning at the center of the span and working toward the ends. For continuous spans, concrete shall be deposited as shown on the plans. Concrete in girders shall be uniformly deposited for the full length of the girder and brought up evenly in horizontal layers.

Unless otherwise permitted by the Engineer, concrete shall not be placed in the superstructure until the column forms have been stripped sufficiently to determine the character of the concrete in the columns. Unless otherwise permitted by the Engineer, the load of the superstructure shall not be placed on pile bents until the caps have been in place at least seven days and shall not be placed on other types of bents until the bents have been in place at least 14 days.

In placing concrete around steel shapes, it shall be placed on one side of the shape until it flushes up over the bottom flange of the shape on the opposite side, after which it shall be placed on both sides to completion.

Concrete in girder haunches less than three feet in height shall be placed at the same time as that in the girder stem. Whenever a haunch or fillet has a height of three feet or more at the abutment or columns, the haunch and the girder shall be poured in three successive stages: first, up to the lower side of the haunch; second, to the lower side of the girder; and third, to completion.

Except when intermediate construction joints are specified, concrete in slab, T-beam, or deck-girder spans shall be placed in one continuous operation for each span.

The floors and girders of through-girder superstructures shall be placed in one continuous operation unless otherwise specified, in which case special shear anchorage shall be provided to insure monolithic action between girder and floor.

Concrete in box girders shall be placed as shown on the plans.

Concrete shall not be chuted directly into the forms of the span and shall be placed continuously with sufficient speed to be monolithic and to allow for finishing before initial set.

804.03.7--Pneumatic Placing. Pneumatic placing of concrete will be permitted only if specified in the contract or if authorized by the Engineer. The equipment shall be so arranged that no vibrations result which might damage freshly placed concrete.

Where concrete is conveyed and placed by pneumatic means the equipment shall be suitable in kind and adequate in capacity for the work. The machine shall be located as close as practicable to the place of deposit. The position of the discharge end of the line shall not be more than 10 feet from the point of deposit. The discharge lines shall be horizontal or inclined upwards from the machine. At the conclusion of placement the entire equipment shall be thoroughly cleaned.

804.03.8--Pumping Concrete. Placement of concrete by pumping will be permitted only if specified in the contract or if authorized in writing by the Engineer. If used, the equipment shall be arranged so that no vibrations result which might damage freshly placed concrete.

Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall be suitable in kind and adequate in capacity for the work. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipe line, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. After this operation, the entire equipment shall be thoroughly cleaned.

The use of aluminum pipe as a conveyance for the concrete will not be permitted.

804.03.9--Depositing Concrete Under Water. Concrete shall not be deposited in water except with the approval of the Engineer.

Concrete deposited under water shall be Class S.

Concrete deposited under water shall be carefully placed in a compact mass in its final position by means of a tremie, a bottom dump bucket, or other approved method and shall not be disturbed after being deposited. Special care shall be exercised to maintain still water at the point of deposit. No concrete shall be placed in running water and all form work designed to retain concrete under water shall be water-tight. The consistency of the concrete shall be carefully regulated, and special care shall be exercised to prevent segregation of materials.

Concrete seals shall be placed continuously from start to finish, and the surface of the concrete shall be kept as nearly horizontal as practicable at all times. To insure thorough bonding, each succeeding layer of a seal shall be placed before the preceding layer has taken initial set.

When a tremie is used, it shall consist of a tube having a diameter of at least 10 inches and constructed in sections having flanged couplings fitted with gaskets. The means of supporting the tremie shall be such as to permit the free movement of the discharge over the entire top surface of the work and to permit it to be lowered rapidly when necessary to choke off or retard the flow of concrete. The discharge end shall be closed at the start of the work so as to prevent water entering the tube and shall be entirely sealed. The tremie tube shall be kept full to the bottom of the hopper. When a batch is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end, always keeping it in the deposited concrete. The flow is then stopped by lowering the tremie. The flow shall be continuous until the work is completed.

Depositing of concrete by the drop bottom bucket method shall conform to the following: The top of the bucket shall be open. The bottom doors shall open freely downward and outward when tripped. The bucket shall be completely filled and slowly lowered to avoid backwash. It shall not be dumped until it rests on the surface upon which the concrete is to be deposited and when discharged shall be withdrawn slowly until well above the concrete.

Dewatering may proceed when the concrete seal is sufficiently hard and strong. As a general rule, this time will be 48 hours for concrete made with high-early-strength cement and three days for concrete made with other types of cement. All laitance and other unsatisfactory material shall be removed from the exposed surface by scraping, chipping, or other means which will not injure the surface of the concrete.

804.03.10--Construction Joints.

804.03.10.1--General. Unless otherwise approved by the Engineer, construction joints shall be made only where located on the plans or shown in the pouring schedule. If not detailed on the plans, or in the case of emergency, construction joints shall be placed as directed by the Engineer. Shear keys or inclined

reinforcement shall be used where necessary to transmit shear or to bond the two sections together.

For continuous spans, bridge deck concrete shall be deposited as shown on the plans. Deviation from the pouring schedule shown in the plans is not permitted.

804.03.10.2--Bonding. Before depositing new concrete on or against concrete which has hardened, the forms shall be retightened. The surface of the hardened concrete shall be roughened as required by the Engineer and in a manner that will not leave loosened particles of aggregate or damaged concrete at the surface. It shall be thoroughly cleaned of foreign matter and laitance and saturated with water. When directed by the Engineer, the cleaned and saturated surfaces, including vertical and inclined surfaces, shall first be thoroughly covered with a coating of mortar or neat cement grout against which the new concrete shall be placed before the grout has attained its initial set.

The placing of concrete shall be carried continuously from joint to joint. The face edges of all joints which are exposed to view shall be carefully finished, true to line and elevation.

In order to bond successive courses suitable depressed or raised keys of the designated size shall be constructed. Raised keys shall be monolithic with the concrete of the lower course.

804.03.11--Concrete Exposed to Seawater. Unless otherwise specifically provided, concrete for structures exposed to seawater shall be Class AA concrete as referenced in Subsection 804.02.10. The clear distance from the face of the concrete to the nearest face of reinforcing steel shall be at least four inches. The mixing time and the water content shall be carefully controlled and regulated so as to produce concrete of maximum impermeability. The concrete shall be thoroughly compacted, and stone pockets shall be avoided. No construction joints shall be formed between the levels of extreme low water and extreme high water as determined by the Engineer. Between these levels, seawater shall not come in direct contact with the new concrete until at least 30 days have elapsed. The surface concrete as left by the forms shall be left undisturbed.

804.03.12--Blank.

804.03.13--Falsework. The Contractor shall submit to the Engineer four copies of structural design analysis and detail drawings, which show the method of falsework or centering. These designs and detail plans shall be prepared and bear the seal of a Registered Professional Engineer with experience in falsework design.

Falsework plans shall include falsework elevations together with all other dimensions and details which is considered necessary for the construction.

Other pertinent data needed is size and spacing of all falsework members and minimum bearing requirements for false piles.

Upon completion of falsework erection, the Registered Professional Engineer shall certify that the erected falsework is capable of supporting the load for construction.

Falsework piling shall be spaced and driven so that the bearing value of each pile is sufficient to support the load that will be imposed upon it. The bearing value of the piles should be calculated according to the appropriate formula given in Section 803.

For designing falsework and centering, a weight of 150 pounds per cubic foot shall be assumed for green concrete. All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads without appreciable settlement or deformation. The Contractor may be required to employ screw jacks or hardwood wedges to take up slight settlement in the falsework either before or during the placing of concrete. An allowance shall be made for anticipated compressibility of falsework and for the placement of shims, wedges, or jacks to produce the permanent structural camber shown on the plans. If during construction, any weakness develops and the falsework shows any undue settlement or distortion, the work shall be stopped, the part of the structure affected removed, and the falsework strengthened before work is resumed. Falsework which cannot be founded on a satisfactory footing shall be supported on piling, which shall be spaced, driven, and removed, as referenced in Subsection 804.03.15, in a manner approved by the Engineer.

All structures built across a public street or highway on which maintenance of traffic is required, shall have falsework so arranged that a vertical clearance of at least 12' 6" is provided. Unless otherwise specified, a horizontal clearance of at least the width of the traveled way shall be provided at all times. If the vertical clearance is less than 13' 6" or the horizontal clearance is less than the full crown width of the roadway, the Contractor shall install and maintain appropriate safety devices, clearance signs and warning lights, and shall notify the Engineer sufficiently in advance of restricting the clearance for the Engineer to advise both the Traffic Engineering and the Maintenance Divisions. All traffic control and safety devices shall be in accordance with the Manual on Uniform Traffic Control Devices (MUTCD).

804.03.14--Forms.

804.03.14.1--General. Forms shall be wood, metal, or other material approved by the Engineer. All forms shall be built mortar-tight and sufficiently rigid to prevent distortion due to pressure of the concrete and other loads incident to the construction operations. Forms shall be constructed and maintained so as to prevent warping and the opening of joints due to shrinkage. The forms shall be

substantial and unyielding and shall be so designed that the finished concrete will conform to the proper dimensions and contours. The design of the forms shall take into account the effect of vibration of concrete as it is placed.

Minimum requirements for slab overhang forms shall be 3/4-inch plywood supported on 2-inch x 6-inch S4S wood timbers placed flatwise on 16-inch centers.

Adjustable brackets for support of slab overhang forms shall be spaced at a maximum distance of 3' 0" center to center unless specifically approved otherwise. Grade points for forms shall coincide with the location of the adjustable form brackets.

Forms for surfaces exposed to view shall be of uniform thickness with a smooth inside surface of an approved type. Joints in forms for exposed surfaces shall be closely fitted to eliminate fins, stone pockets, or other variations in the surface of the concrete which would mar a smooth and uniform texture.

Forms shall be filleted at all sharp corners and shall be given a bevel or draft in the case of all projections, such as girders and copings, to insure easy removal.

Metal ties or anchorages within the forms shall be so constructed as to permit their removal, without injury to the concrete, to a depth of at least the reinforcing steel clearance shown on the plans. In case ordinary wire ties are permitted, all wires, upon removal of the forms, shall be cut back at least 1/4 inch from the face of the concrete with chisels or nippers. Nippers shall be used for green concrete. All fittings for metal ties shall be designed so that upon their removal the cavities which are left will be the smallest practicable size. The cavities shall be filled with cement mortar and the surface left sound, smooth, even, and uniform in color.

Forms shall be set and maintained to the lines designated until the concrete is sufficiently cured for form removal. Forms shall remain in place for periods which shall be determined as hereinafter specified. If forms are deemed to be unsatisfactory in any way, either before or during the placing of concrete, the Engineer will order the work stopped until the defects have been corrected.

The shape, strength, rigidity, water-tightness, and surface smoothness of reused forms shall be maintained at all times. Warped or bulged lumber shall be resized before being reused. Forms which are unsatisfactory in any respect shall not be reused.

Access to the lower portions of forms for narrow walls and columns shall be provided for cleaning out extraneous material immediately before placing the concrete.

All forms shall be treated with an approved oil or saturated with water immediately before placing the concrete. For rail members or other members with exposed faces, the forms shall be treated only with an approved oil to prevent the adherence of concrete. Any material which will adhere to or discolor the concrete shall not be used.

When metal forms are used they shall be kept free from rust, grease, or other foreign matter which will discolor the concrete. They shall be of sufficient thickness and so connected that they will remain true to shape and line, and shall conform in all respects as herein prescribed for mortar tightness, filleted corners, beveled projections, etc. They shall be constructed so as to insure easy removal without injury to concrete. All inside bolt and rivet heads shall be countersunk.

All chamfer strips shall be dressed, straight, and of uniform width and shall be maintained as such at all times.

804.03.14.2--Stay-In-Place Metal Forms. The use of stay-in-place metal forms will not be allowed.

804.03.15--Removal of Falsework, Forms, and Housing. In the determination of the time for the removal of falsework, forms, and housing and the discontinuance of heating, consideration shall be given to the location and character of the structure, the weather and other conditions influencing the setting of the concrete, and the materials used in the mix. No forms or supports shall be removed prior to approval by the Engineer. During cold weather, removal of housing and the discontinuance of heating shall be in accordance with Subsection 804.03.16.1.

Concrete in the last pour of a continuous superstructure shall have attained a compressive strength of 2,400 psi, as determined by cylinder tests, prior to striking any falsework. It is important that falsework be removed as evenly as possible to prevent excessive deflection stresses in the spans.

At the Contractor's option and with the approval of the Engineer, the time for removal of forms may be determined by cylinder tests, in which case the Contractor shall furnish facilities for testing the cylinders. The facilities shall include an approved concrete testing machine of sufficient capacity and calibrated by an acceptable commercial laboratory. Tests shall be conducted in the presence of a Department representative to witness and record strengths obtained on each break or performed by a Department certified technician in an approved testing laboratory.

When form removal or placing of beams is not controlled by cylinder tests, Column A, exclusive of the days when the ambient temperature is below 40°F, herein shall apply as a guide for removal of forms and falsework. When cylinder tests are used, Column B shall be used. The cylinders shall be cured under

conditions which are not more favorable than those existing for the portions of the structure which they represent.

If Type IP cement or Type I or II Portland cement plus fly ash is used, only Column B will be applicable.

	<u>Column A</u> <u>Minimum Cure</u>	<u>Column B</u> <u>Minimum PSI</u>
Forms:		
Columns	24 Hours	1000
Side of Beams	24 Hours	1000
Walls not under pressure	24 Hours	1000
Floor Slabs, overhead	7 Days	2000
Floor Slabs, between beams	7 Days	2000
Slab Spans	14 Days	2400
Other Parts	24 Hours	1000
Centering:		
Under Beams	14 Days	2400
Under Bent Caps	7 Days	2000
Limitation for Placing Beams on:		
Pile Bents, pile under beam	3 Days	2000
Frame Bents, two or more columns	7 Days	2200
Frame Bents, single column	14 Days	2400

Methods of form removal likely to cause overstressing of the concrete shall not be used. Forms and supports shall be removed in a manner that will permit the concrete to uniformly and gradually take the stresses due to its own weight. Centers shall be gradually and uniformly lowered in a manner that will avoid injurious stresses in any part of the structure.

As soon as concrete for railings, ornamental work, parapets and vertical faces which require a rubbed finish has attained a safe strength, the forms shall be carefully removed without marring the surfaces and corners, the required finishing performed, and the required curing continued.

Prior to final inspection of the work, the Contractor shall remove all falsework, forms, excavated material or other material placed in the stream channel during construction. Falsework piles may be cut or broken off at least one foot below the mudline or ground line unless the plans specifically indicate that they are to be pulled and completely removed from the channel.

804.03.16--Cold or Hot Weather Concreting.

804.03.16.1--Cold Weather Concreting. In cold weather, the temperature of the concrete when delivered to the job site shall conform to the temperature limitations of “Temperature Limitations on Concrete when Delivered to Job Site” listed in Table 6 below.

When the Contractor proposes to place concrete during seasons when there is a probability of ambient temperatures lower than 40°F, the Contractor shall have available on the project the approved facilities necessary to enclose uncured concrete and to keep the temperature of the air inside the enclosure within the ranges and for the minimum periods specified herein.

When there are indications of temperatures of less than 40°F during the first four days after placement of the concrete, the concrete shall be protected from cold temperatures by maintaining a temperature between 50°F and 100°F for at least four days after placement and between 40°F and 100°F for at least three additional days. The Contractor shall use such heating equipment such as stoves, salamanders, or steam equipment as deemed necessary to protect the concrete. When dry heat is used, means of maintaining atmospheric moisture shall be provided.

One or more of the aggregates and/or mixing water may be heated. The aggregates may be heated by steam, dry heat, or by placing in the mixing water which has been heated. Frozen aggregates shall not be used. When either aggregates or water are heated above 100°F, the aggregates and water shall be combined first in the mixer before the cement is added to avoid flash set. Cement shall not be mixed with water or with a mixture of water and aggregate having a temperature greater than 100°F.

The use of salt or other chemical admixtures in lieu of heating will not be permitted.

Before placing concrete, all ice or frost shall be removed from the forms and reinforcement.

In the case of concrete placed directly on or in the ground, such as for footings or bottom slabs, protection and curing during cold weather may be provided as set for concrete pavement under Subsection 501.03.20.3.

The Contractor shall assume all risk and added cost connected with the placing and protecting of concrete during cold weather. Permission given by the Engineer to place concrete during such time will in no way relieve the Contractor of responsibility for satisfactory results. Should it be determined at any time that the concrete placed under such conditions is unsatisfactory, it shall be removed and replaced with satisfactory concrete by the Contractor without extra compensation.

TABLE 6
COLD WEATHER TEMPERATURE LIMITATIONS ON CONCRETE WHEN
DELIVERED TO JOB SITE

Ambient Temperature °F	Minimum Concrete Temperature °F	
	For sections with least dimension less than 12 inches	For sections with least dimensions 12 inches or greater
30 to 45	60	50
0 to 30	65	55
Below 0	70	60

804.03.16.2--Hot Weather Concreting. The manufacture, placement, and protection of concrete during hot weather requires special attention to insure that uniform slump ranges and satisfactory placement qualities are maintained, that surface cracking is held to a minimum, and that design strengths are produced.

804.03.17--Curing Concrete. Concrete surfaces shall be protected from premature drying by covering as soon as possible with a satisfactory curing material. When wetted burlap is used, it shall be not less than two thicknesses of Class 3 burlap or its equivalent, and the burlap shall be kept continuously and thoroughly wet. Careful attention shall be given to the proper curing and protection of concrete, and curing by the wetting method shall continue for a period of at least seven days after placing the concrete. If high-early-strength cement is used, this period may be reduced to four days.

Surfaces to have a Class 2 rubbed or sprayed finish and bridge deck surfaces when the atmospheric temperature is 90°F or above shall be cured only by wetting methods. The curing of concrete bridges with membrane curing will be permitted only under the conditions specified herein.

Surfaces on which curing is to be by liquid membrane shall be given the required surface finish prior to the application of curing compound. During the finishing period the concrete shall be protected by the water method of curing. Concrete surfaces cured by the liquid membrane method shall receive two applications of curing compound. The first application shall be applied immediately after the finishing is completed and accepted. Prior to applying the first application, the concrete shall be thoroughly wetted with water and the liquid membrane applied just as the surface film of water disappears. The second application shall be applied immediately after the first application has set. The rate of application of curing compound will be as prescribed by the Engineer with a minimum spreading rate per application of one gallon per 200 square feet of concrete surface. The coating shall be protected against marring for at least 10 days after the application of the curing compound. The coating on bridge decks shall

receive extra attention and may require additional protection as required by the Engineer. All membrane marred or otherwise disturbed shall be given an additional coating. Should the surface coating be subjected repeatedly to injury, the Engineer may require that the water curing method be applied at once.

When using curing compound, the compound should be thoroughly mixed within an hour before use. If the use of curing compound results in a streaked or blotched appearance, the method shall be stopped and water curing applied until the cause of defective appearance is corrected.

Other precautions to insure the development of strength shall be taken as directed.

Adequate tarpaulins of ample size shall be on the project and used as necessary to protect the work in case of rain or other emergencies.

Conditions governing the placement of concrete and the requirements for the placement, protection, and curing of concrete during cold or hot weather shall conform to the limitations, conditions, and requirements stipulated in Subsection 804.03.16 as applicable.

804.03.18--Expansion and Fixed Joints, Bearings, Anchor Bolts, Plates, Castings, Pipes, Drains, Conduits, Etc. All joints shall be constructed according to details shown on the plans. The edges of the concrete at open or filled joints shall be chamfered or edged as indicated on the plans.

804.03.18.1--Open Joints. Open joints shall be placed in the locations shown on the plans and shall be constructed by the insertion and subsequent removal of a wood strip, metal plate, or other approved material. The insertion and removal of the template shall be accomplished without chipping or breaking the corners of the concrete. Reinforcement shall not extend across an open joint unless so specified on the plans.

804.03.18.2--Filled Joints. Poured expansion joints and joints to be sealed with premolded materials shall be constructed similar to open joints. When premolded types are specified, the filler shall be placed in correct position as the concrete on one side of the joint is placed. When the form is removed, the concrete on the other side shall be placed. Adequate water stops of metal, rubber, or plastic shall be carefully placed as shown on the plans.

804.03.18.3--Premolded and Preformed Joint Seals. When preformed elastomeric compressive joint seals are specified, the previously formed and cured open joint shall be thoroughly cleaned of all foreign matter, the required adhesive uniformly applied, and the seal installed in accordance with the recommendations of the manufacturer of the seal.

When premolded filler is used for the joints in the roadway slab, the tops shall be adequately sealed with poured joint filler in accordance with details on the plans. Premolded filler shall be permanently fastened to an adjacent concrete surface by appropriate use of copper wire, copper nails, or galvanized nails.

804.03.18.4--Steel Joints. The plates, angles, or other structural shapes shall be accurately shaped at the shop to conform to the section of the concrete floor. Fabrication and painting shall conform to the specifications covering those items. When called for on the plans or in the special provisions, the material shall be galvanized in lieu of painting. Care shall be taken to insure that the surface in the finished plane is true and free of warping. Positive methods shall be employed in placing the joints to keep them in correct position during the placing of the concrete. The opening at expansion joints shall be that designated on the plans at normal temperature, and care shall be taken to avoid impairment of the clearance in any manner.

804.03.18.5--Water Stops. Adequate water stops of metal, rubber, or plastic shall be placed as shown on the plans. Where movement at the joint is provided for, the water stops shall be of a type permitting movement without injury. They shall be spliced, welded, or soldered to form continuous watertight joints.

804.03.18.6--Bearing Devices. Bearing plates, rockers, and other bearing devices shall be constructed according to details shown on the plans. Unless otherwise specified or set in plastic concrete, they shall be set in grout to insure uniform bearing. Structural steel and painting shall conform to the requirements of Sections 810 and 814. When specified, the material shall be galvanized in lieu of painting. The rockers or other expansion bearing devices shall be set, considering the temperature at the time of erection, so that the required position of the device is provided.

At all points of bearing contact, concrete members shall be separated from underlying members by dimensioned bearing pads or by methods and/or materials specified on the plans.

When not otherwise specifically provided, contact areas between concrete superstructures and substructures shall be separated by three layers of No. 15, Type I, roofing felt.

804.03.18.7--Friction Joints. Metal friction joints shall consist of plates as indicated on the plans and shall be securely anchored in correct position. All sliding surfaces shall be thoroughly coated with an approved graphite grease. Movement shall not be impeded by the concrete in which the plates are embedded.

804.03.18.8--Placing Anchor Bolts, Plates, Castings, Grillage, Conduits, Etc. All anchor bolts, plates, castings, grillage, conduits, etc. indicated on the plans to

be placed in or on the concrete shall be placed, set, or embedded as indicated or as directed. These items of the construction shall be set in portland cement mortar as referenced in Subsection 714.11.5, except that anchor bolts may, as permitted by the Engineer, be built into the masonry, set in drilled holes, or placed as the concrete is being constructed by inserting encasing pipe or oiled wooden forms of sufficient size to allow for adjustment of the bolts. After removal of the pipe or forms, the space around the bolts shall be filled with portland cement mortar completely filling the holes. The bolt shall be set accurately and perpendicular to the plane of the seat.

Anchor bolts which are to be set in the masonry prior to the erection of the superstructure shall be carefully set to proper location and elevation with a template or by other suitable means.

When bed plates are set in mortar, no superstructure or other load shall be placed thereon until this mortar has been allowed to set for a period of at least 96 hours, subject to the restrictions for cold weather concreting in Subsection 804.03.16.1. The mortar shall be kept well moistened during this period.

Weep hole drains shall be installed in abutments and retaining walls, and roadway drains or scuppers shall be installed in the roadway slabs in accordance with the details shown on the plans.

Where backfill is to be made at weep holes or openings in the structure, sand or stone chimneys or French drains shall be constructed as specified and shall extend through the portion of the backfill to be drained. Except as otherwise provided, the sand, stone, or slag used in this construction shall meet the requirements of Subsection 704.04.

804.03.19--Finishing Concrete Surfaces.

804.03.19.1--Classes of Finishes. Surface finishes of exposed concrete surfaces shall be classified as follows:

- Class 1 - Ordinary Surface Finish
- Class 2 - Rubbed or spray Finish
- Class 3 - Tooled Finish
- Class 4 - Sand-Blast Finish
- Class 5 - Wirebrush or Scrubbed Finish
- Class 6 - Floated Surface Finish

804.03.19.2--Class 1, Ordinary Surface Finish. Immediately following the removal of forms, all fins and irregular projections shall be removed from all surfaces except from those which are not to be exposed or not to be waterproofed. On all surfaces, the cavities produced by form ties and all other holes, honeycomb spots, broken corners or edges, and other defects shall be

thoroughly cleaned, and after having been kept saturated with water for at least three hours shall be carefully pointed and trued with a mortar of cement and fine aggregate mixed in the proportions used in the class of the concrete being finished. Mortar used in pointing shall be not more than one hour old. The mortar patches shall be cured as specified under Subsection 804.03.17. All construction and expansion joints shall be left carefully tooled and free of mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges.

The resulting surfaces shall be true and uniform. All surfaces which cannot be repaired to the satisfaction of the Engineer shall be given a Class 2 rubbed finish.

804.03.19.3--Class 2, Rubbed or Spray Finish.

804.03.19.3.1--Rubbed Finish. After removal of forms, the Class 1 finish shall be completed and the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work, the concrete shall be kept thoroughly saturated with water for at least three hours. Surfaces shall be rubbed with a medium course Carborundum stone using a small amount of mortar on its face. The mortar shall be composed of cement and sand mixed in the proportions used in the concrete being finished. Rubbing shall be continued until all form marks, projections, and irregularities have been removed, all voids are filled, and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place at this time.

After all concrete above the surface being treated has been cast, the final finish shall be obtained by rubbing with a fine Carborundum stone and water. This rubbing shall continue until the entire surface is of a smooth texture and uniform color.

After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and objectionable marks.

804.03.19.3.2--Spray Finish. Prior to the spray finish, the concrete shall be given a Class 1 finish in accordance with Subsection 804.03.19.2, supplemented if necessary with a grout meeting the requirements of Subsection 714.11 with fine aggregate modified to require 100 percent passing the No. 16 Sieve.

Grout shall be applied with burlap pads or float sponges, and as soon as the grout has dried the surface shall be brushed to remove all loose grout and the surface left smooth and free of air holes. Surfaces to be sprayed shall be free of efflorescence, flaking coatings, dirt, oil, and other foreign substances. Prior to application of the spray finish, the surfaces shall be free of moisture, as determined by sight and touch, and in a condition consistent with the manufacturer's published recommendations.

The spray finish material shall meet the requirements of Subsection 714.12 and shall be listed on of Approved Sources of Materials. The spray finish shall be applied with heavy duty spray equipment capable of maintaining a constant pressure as necessary for proper application. The material shall be applied as recommended by the manufacturer except the rate of application shall not be less than one gallon per 50 square feet of surface area without prior written approval of the Engineer.

The completed finish shall be tightly bonded to the structure and present a uniform appearance and texture equal to or better than a rubbed finish. If necessary, additional coats shall be sprayed to produce the desired surface texture and uniformity. Upon failure to adhere positively to the structure without chipping or cracking or to attain the desired surface appearance, the coatings shall be completely removed and the surface given a rubbed finish in accordance with 804.03.19.3.1, or other approved methods shall be used to obtain the desired surface finish to the satisfaction of the Engineer without additional cost to the State.

804.03.19.4--Classes 3, 4, and 5 Finishes. If required, specifications for these finishes will be contained in the special provisions.

804.03.19.5--Class 6, Floated Surface Finish. After the concrete has been deposited in place, it shall be consolidated and the surface shall be struck off by means of a strike board and floated with a wooden or cork float. An edging tool shall be used on edges and expansion joints. The surface shall not vary more than 1/8 inch under a 10-foot straightedge. The surface shall have a granular or matte texture which will not be slick when wet.

804.03.19.6--Required Finishes for Various Surfaces.

804.03.19.6.1--General. Unless otherwise specified, the top surface of sidewalks, the top horizontal surfaces of footings, and top slabs of box bridges, box culverts, or other structures shall be given a Class 6 finish. All formed concrete surfaces shall be given a Class 1 finish, except on surfaces which are completely enclosed, such as the inside surfaces of cells of box girders, the removal of fins and form marks and the rubbing of mortared surfaces to a uniform color will not be required.

In reference to finishing, exposed surfaces are surfaces or faces which may be seen after all backfill has been placed. Exposed surfaces requiring a Class 2 finish shall be finished at least one foot below the ground line or the low water elevation, whichever is higher.

The Class 2 finish shall be made upon a Class 1 finish. After the removal of forms the Class 1 finish shall be completed and the rubbing of concrete shall be started as soon as the condition of the concrete will permit.

Bridge floors shall be finished in accordance with Subsection 804.03.19.7.

804.03.19.6.2--Finishing Formed Concrete Surfaces of Box Bridges, Box Culverts, Pipe Headwalls, and Minor Structures. The exposed surfaces of wing walls and parapets of box bridges and box culverts to be used as vehicular or pedestrian underpasses shall be given a Class 2 finish. Exposed surfaces of other box culverts or box bridges, pipe culvert headwalls, and other minor structures shall be given a Class 1 finish unless otherwise indicated on the plans.

The exposed surfaces of retaining walls including copings and parapets shall receive a Class 2 finish.

804.03.19.6.3--Finishing Formed Concrete Surface of Bridges. All formed concrete bridge surfaces which are exposed shall have a Class 1 or 2 finish as set forth herein unless designated otherwise on the plans.

Bridges with designated surfaces for Class 2 finish are classified as follows:

- Group A - Bridges over highways, roads and streets.
- Group B - Bridges over waterways and railroads.
- Group BB - Twin or adjacent bridges of Group B category.

When a Group B or BB bridge also spans a highway, road or street, exposed concrete surfaces shall be finished in accordance with Group A requirements.

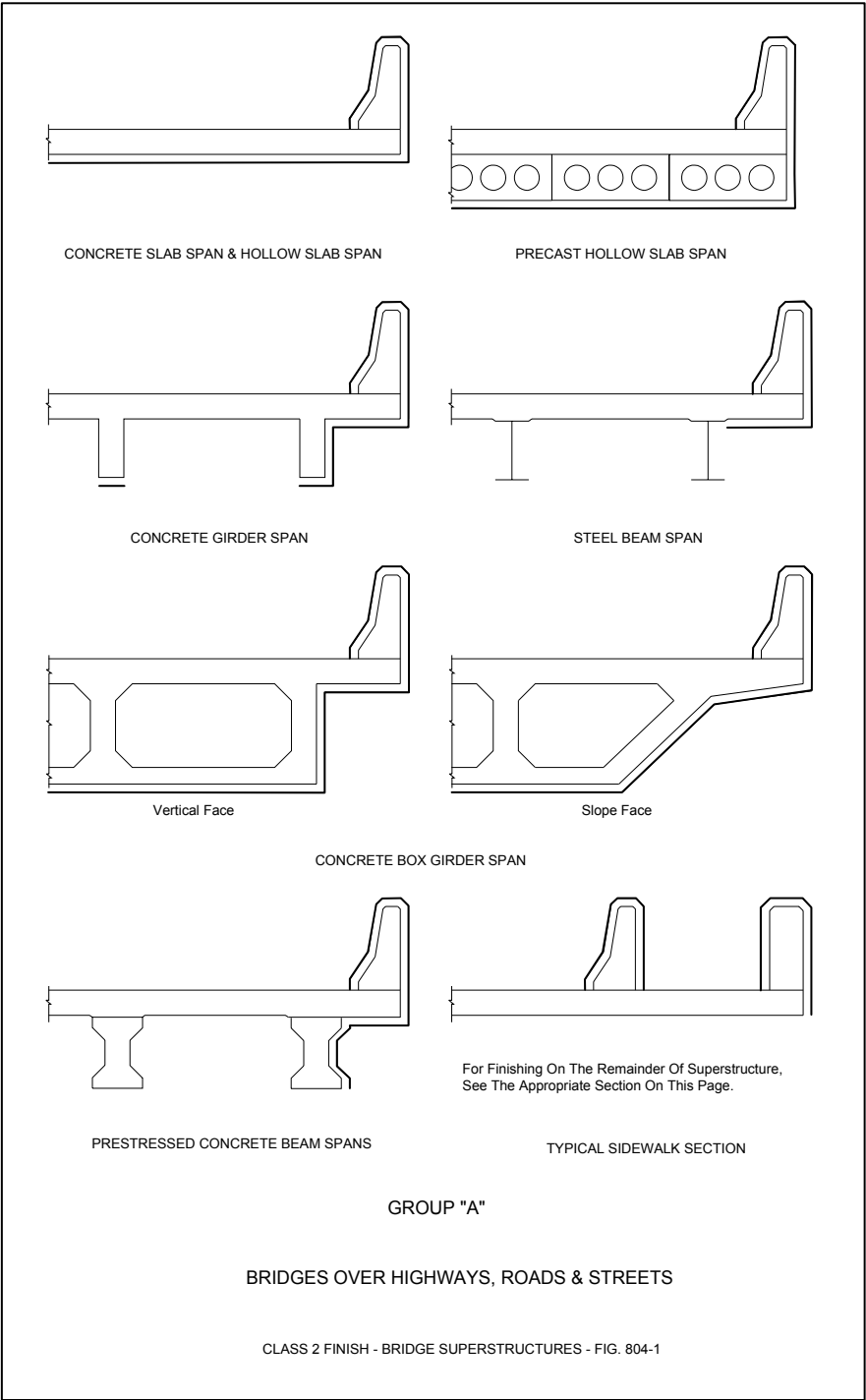
(A) Superstructures. Concrete surfaces to be given a Class 2 finish shall be the exposed surfaces of wings and rails and other exposed surfaces indicated by a double line in Figures 804-1, 804-2, and 804-3.

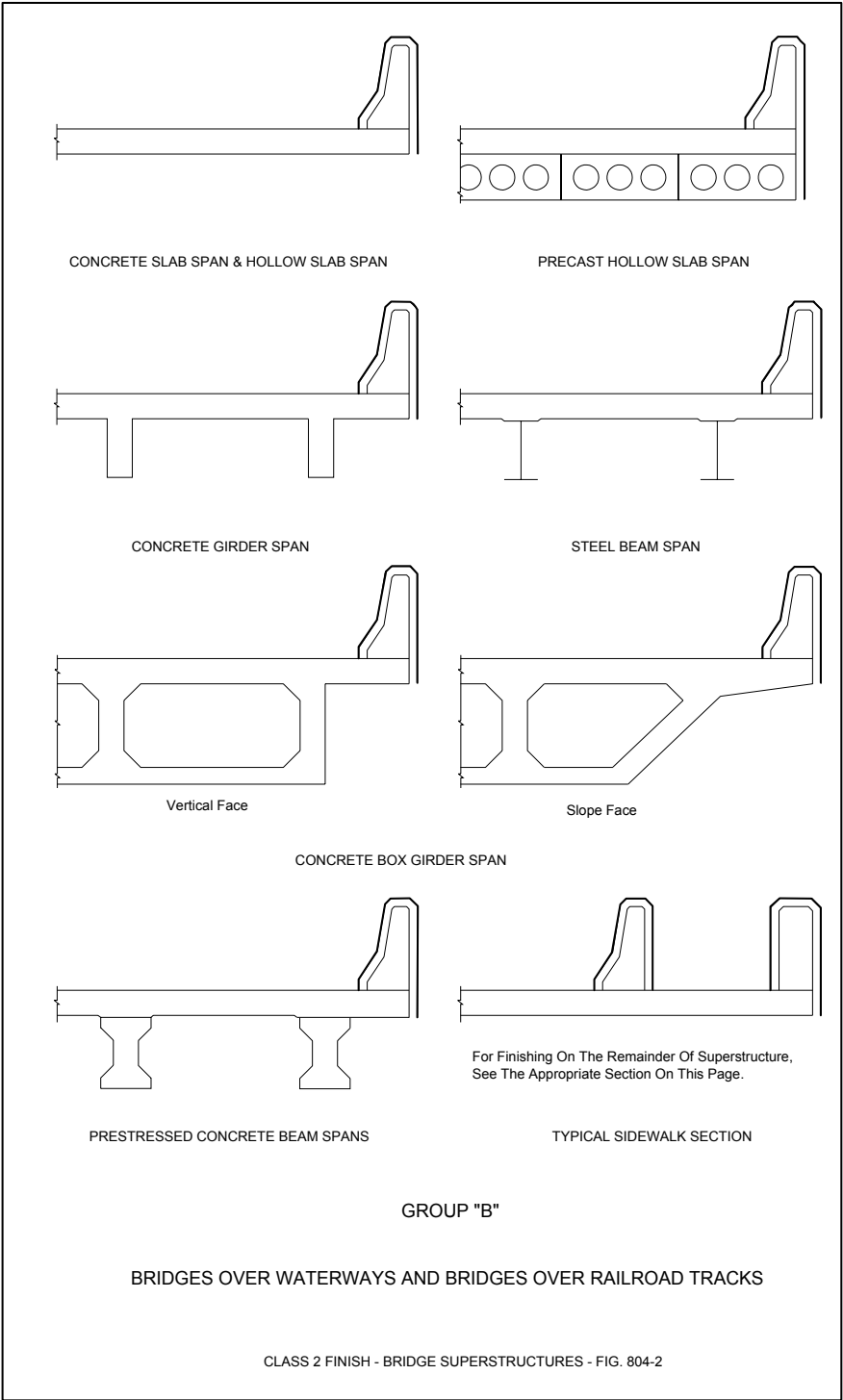
When a Group B or BB also spans a highway, road or street, the superstructure of spans over and extending one span in each direction beyond the lower level highway, road or street shall be given a Class 2 finish as shown for Group A.

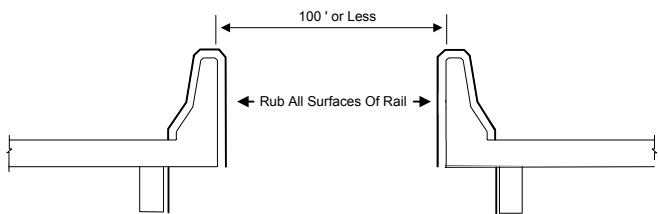
(B) Substructures. Concrete surfaces to be given a Class 2 finish are as follows:

Group A. Exposed surfaces of abutments, end bents, end bent posts, wing walls, railing, retaining walls, parapets, copings, piers, columns, piles, caps, struts or walls between columns or piles, encasement of steel piles, arch rings and spandrel walls.

Group B and BB. Exposed surfaces of abutments, wing walls, end bent posts, railing, retaining walls, parapets and copings.







GROUP "B B" - ADJACENT BRIDGES

GROUP "B B"

TWIN or DUAL BRIDGES

CLASS 2 FINISH - BRIDGE SUPERSTRUCTURES - FIG. 804-3

804.03.19.7--Finishing Bridge Floors.

804.03.19.7.1--General. Concrete bridge decks shall be struck off and finished by the method(s) designated on the plans.

In the event a method is not designated, the Contractor may use either the longitudinal or transverse method subject to the requirements contained in these specifications.

Except when indicated otherwise on the plans, the final surface texture of the bridge floor shall be either a drag, belt, or broom finish. The surface texture specified and surface requirements shall be in accordance with the applicable requirements of Subsections 501.03.17 and 501.03.18 modified only as the Engineer deems necessary for bridge deck construction operations.

804.03.19.7.2--Longitudinal Method. The longitudinal method requires that the strike-off screed be supported on accurately graded and supported bulkheads or templates placed across the full width at the end(s) of the pour. Before the concrete is placed, approved fixed templates or wooden bulkheads of not less than 1¼-inch lumber shall be placed perpendicular to the centerline of the roadway, or in the case of skew bridges at the angle of skew. The upper surface of the template or bulkheads shall be accurately set to conform to the required grade and crown.

Special attention shall be given to the gutter lines where the strike-off screed cannot reach. The gutters shall be finished by hand and tested with the straight edge. Floor drains shall be set lower than the finished gutter line and finished over. After initial set, the concrete shall be dished out and finished around the drains to form an outlet.

After the concrete has been deposited and rough graded, it shall be struck off by means of a strike-off screed resting on the bulkheads or fixed templates. The strike-off screed shall be of a type satisfactory to the Engineer and shall have sufficient strength to retain its shape under all working conditions. The final surface shall comply with the applicable requirements of Subsections 501.03.17.6 and 501.03.18, and unless otherwise specified in the contract, the final finish under this method shall be the belt finish.

In general, the overall strike-off screed should be trussed, with bracing heavy enough to support the weight of a man without deflecting, and should be adjustable for camber and correction of sag.

The strike-off screed will ride on the bulkheads or fixed templates at the ends of the section being finished. Care shall be taken to see that the bulkhead or fixed template elevations are accurately set since the entire span surface will be

controlled by them. The manipulation of the screed shall be such that neither end is raised from the bulkheads or templates during the process.

The concrete shall be struck off by beginning at one curb and proceeding entirely across the span. A slight excess of concrete shall be kept in front of the cutting edge at all times. This operation shall be repeated at least three times. In each case, the strike-off screed shall be picked up and carried back to the point of beginning. No backward strokes will be allowed. The strike-off screed shall be moved along the bulkheads or fixed templates with a combined longitudinal and transverse motion. This operation may be manual or mechanical. Standing or walking in the fresh concrete ahead of the strike-off screed will not be permitted.

804.03.19.7.3--Transverse Method. The transverse method requires that the screeding equipment be supported on accurately graded and supported rails placed beyond the gutter lines and parallel with the centerline of the bridge.

The machine shall be so constructed and operated as to produce a bridge floor of uniform density with minimum manipulation of the fresh concrete and achieved in the shortest possible time. Manual transverse methods of screeding will not be permitted.

The finishing machine shall be supported on vertically adjustable rails set a sufficient distance from the gutter line to allow free movement of the screed from gutter line to gutter line. Satisfactory means of load distribution with minimum rail deflection shall be provided. The screed rails for a deck pour shall be completely in place for the full length of the pour and shall be firmly secured prior to placing concrete. The screed rails shall be adjusted as necessary to compensate for settlement and deflection occurring during the screeding operations. Supports for the screed rail shall be located directly over slab overhang support brackets as referenced in Subsection 804.03.14.1.

At least one dry run shall be made the length of each pour with a "tell-tail" device attached to the screed carriage to assure the specified clearance to the reinforcing steel.

The screed shall be equipped with a metal cutting edge or other approved mechanical means for accurately fine grading the plastic concrete to the required grade and surface smoothness and shall be supported by a bridging structure sufficiently rigid and heavy to perform operations satisfactorily on concrete of minimum slump without vibration, distortion, and wrecking of forms. The screed shall be mechanically actuated to deliver the screeding action and for travel in a longitudinal direction at a uniform rate along the bridge floor.

The screed shall complete sufficient passes to strike off all of the excess concrete with ample mortar along the entire leading edge to assure filling of low spots.

Care shall be taken to remove all objectionable material from the gutters where final hand finishing will be required.

The selection of the transverse method may require the Contractor to furnish bridge deck concrete which contains an approved water-reducing set retarding admixture in the quantities approved by the Engineer at no additional cost to the State. See Subsection 713.02 for more information.

Other finishing requirements shall be in accordance with the general requirements in Subsection 804.03.19.7.1 and as specified on the plans.

804.03.19.7.4--Acceptance Procedure for Bridge Deck Smoothness. After the bridge decks and bridge end slabs are completed and preferably before the construction of the bridge railing, they shall be tested for ride quality using a Contractor furnished profilograph. Profile Index Values shall be determined in accordance with Department SOPs and these specifications. The profilograph shall meet the requirements of Subsection 401.02.6.5. Profiles will be obtained in the wheel paths of the main thru lanes and, where conditions allow, in the wheel paths of any auxiliary lanes or tapers. Profile Index Values for bridge decks and bridge end slabs shall be obtained for all state roads with four lanes or more, on state roads three lanes or less where the current traffic count is 2,000 ADT or higher, or as designated on the plans. Ride quality tests will begin at a point where the rearmost wheel of the profilograph is as close to the beginning of the bridge end slab as possible and shall proceed forward across the remainder of the bridge end slab, across the bridge deck and continue across the next bridge end slab to a point where the front-most wheel of the profilograph reaches the far-most edge of the bridge end slab. Bridges and bridge end slabs not requiring a ride quality test must meet a 1/8 inch in 10-foot straightedge requirement in longitudinal and transverse directions. Bridges in horizontal curves having a radius of less than 1,000 feet at the centerline and bridges within the superelevation transition of such curves are excluded from a test with the profilograph.

The Profile Index Value for bridge decks including the bridge end slabs shall be averaged for the left and right wheel path for each lane and where applicable, each auxiliary lane and taper, and shall not exceed 65 inches per mile for each lane. In addition, individual bumps or depressions exceeding 0.3 of an inch, when measured from a chord length of 25 feet, shall be corrected and the surface shall meet a 1/8 inch in 10-foot straightedge check made transversely across the deck or slab.

Bridge decks and bridge end slabs not meeting the preceding requirements shall be corrected. Corrective work shall be done at no additional cost to the Department. Corrective work shall consist of grinding the bridge deck in accordance with this specification. All corrective work shall precede final surface texturing. After completion of final surface texturing, all surface areas

corrected by grinding shall be sealed with a nonstaining 40% minimum alkylalkoxysilane penetrating sealant applied per the manufacturer's directions.

In case the bridge end slabs are to be constructed on a future project, the bridge deck(s) alone shall be tested for ride quality using the acceptance procedure outlined above, except that the ride quality test will begin at a point where the rearmost wheel of the profilograph is as close to the beginning of the bridge as possible and shall proceed forward across the bridge deck to a point where the front-most wheel of the profilograph reaches the far-most edge of the bridge.

Expansion joint installation shall be delayed and the joint temporarily bridged to facilitate operation of the profilograph and grinding equipment across the joint wherever feasible.

It shall be the Contractor's responsibility to schedule profilograph testing. The Contractor shall notify the Department at least five (5) days in advance of profilograph testing. The Contractor shall ensure that the area to be tested has been cleaned and cleared of all obstructions. Profilograph testing of bridge decks and bridge end slabs shall be performed by the Contractor under supervision of the Engineer. All profilograph testing shall be performed at no additional cost to the Department. The Contractor will be responsible for traffic control associated with this testing operation.

804.03.19.7.4.1--Grinding Bridge Decks.

804.03.19.7.4.1.1--Equipment. The grinding equipment shall be a power driven, self-propelled machine that is specifically designed to smooth and texture Portland cement concrete pavement with diamond blades. The effective wheel base of the machine shall not be less than 12.0 feet. It shall have a set of pivoting tandem bogey wheels at the front of the machine and the rear wheels shall be arranged to travel in the track of the fresh cut pavement. The center of the grinding head shall be no further than 3.0 feet forward from the center of the back wheels.

The equipment shall be of a size that will cut or plane at least 3.0 feet wide. It shall also be of a shape and dimension that does not encroach on traffic movement outside of the work area. The equipment shall be capable of grinding the surface without causing spalls at cracks, joints, or other locations.

804.03.19.7.4.1.2--Grinding. The grinding areas will be determined by the Contractor and approved by the Engineer. The Contractor shall develop and submit to the Engineer for approval a Grinding Plan. The Contractor shall allow up to 45 days for the Department to review the Plan prior to starting any grinding operations. This plan shall include as a minimum:

- 1) Name of the project superintendent in responsible charge of the grinding operation.
- 2) List and description of all equipment to be used.
- 3) Maximum depth of each pass allowed by the grinding equipment.
- 4) Maximum width of each pass allowed by the grinding equipment.
- 5) Details of a sequence of the grinding operation.
- 6) Complete data from Profilograph runs, based on a 0.3 inch bump height, for each wheel path over the entire bridge including bridge end slabs, which shall include profile index, bump locations (in stations), bump heights and proposed final cross-slopes. When a computerized profilograph is used, a complete printout of the profile including the header information for each wheel path will be required.
- 7) Data showing reinforcing steel clearance in all areas to be ground.
- 8) A detailed drawing of the deck showing areas to be ground with station numbers and grinding depths clearly indicated.
- 9) A description of grinding in areas where drains are in conflict with grind areas.
- 10) Details of any changes in deck drainage, anticipated ponding, etc.

The Engineer will evaluate the grinding plan for conformance with the plans and specifications, after which the Engineer will notify the Contractor of any additional information required and/or changes that may be needed. Any part of the plan that is unacceptable will be rejected and the Contractor shall submit changes for reevaluation. All approvals given by the Engineer shall be subject to trial and satisfactory performance in the field, and shall not relieve the Contractor of the responsibility to satisfactorily complete the work.

The construction operation shall be scheduled and proceed in a manner that produces a uniform finished surface. Grinding will be accomplished in a manner that eliminates joint or crack faults while providing positive lateral drainage by maintaining a constant cross-slope between grinding extremities in each lane. Auxiliary or ramp lane grinding shall transition as required from the mainline edge to provide positive drainage and acceptable riding surface.

The operation shall result in a finished surface that conforms as close as possible to the typical cross-section and the requirements specified in Subsection 804.03.19.7.4.1.3.

The Contractor shall establish positive means for removal of grinding residue. Residue shall not be permitted to flow across lanes used by public traffic or into gutters or drainage facilities.

804.03.19.7.4.1.3--Final Surface Finish. The grinding process shall produce a finish surface that is as close as possible to grade and uniform in appearance with a longitudinal line type texture. The line type texture shall contain parallel longitudinal corrugations that present a narrow ridge corduroy type appearance.

The peaks of the ridges shall be approximately 1/16 inch higher than the bottoms of the grooves with approximately 53 to 57 evenly spaced grooves per foot. Grinding chip thickness shall be a minimum of 0.080 inches thick.

The finished bridge decks and bridge end slabs shall be retested for riding quality using a Contractor furnished profilograph meeting the requirements of 401.02.6.5. The finished results shall meet the following conditions:

- (a) Individual bumps or depressions shall not exceed 0.3 inches when measured from a chord length of 25 feet.
- (b) The final index value for the bridge deck and bridge end slabs shall be an average of both the right and left wheel paths of each lane and shall not exceed 65 inches per mile.

The final profilogram will be furnished to the Engineer for informational purposes.

804.03.19.8--Finishing Horizontal Surfaces of Footings or Top Slabs of Box Bridges, Culverts, or Other Structures. The finishing of horizontal surfaces of footing or top slabs of box bridges, culverts, or other structures shall be achieved by placing an excess of material in the form and removing or striking off the excess with a template, forcing the coarse aggregate below the mortar surface. After the concrete has been struck off the surface shall be given a Class 6 finish.

804.03.19.9--Finishing Exposed Surfaces of Sidewalks. After the concrete has been deposited in place it shall be consolidated and the exposed surface shall be given a Class 6 finish. An edging tool of the required radius shall be used on all edges and at all expansion joints. The surface shall have a granular texture which will not be slick when wet.

Sidewalk surfaces shall be laid out in blocks with an approved grooving tool as shown on the plans or as directed.

804.03.20--Opening Bridges.

804.03.20.1--Public Traffic. Unless otherwise specified, concrete bridge floors shall be closed to public highway traffic for a period of at least 21 days after placing concrete.

804.03.20.2--Construction Traffic. Unless otherwise specified, concrete bridge floors shall be closed to construction traffic for a period of seven days after placing concrete and the minimum required compressive strength for the concrete placed is obtained.

804.03.21--Final Cleanup. Upon completion of the work all equipment, surplus materials, forms, and waste material shall be removed, the bridge cleaned, and the site of the work given a final cleanup.

804.03.22--Precast-Prestressed Concrete Bridge Members.

804.03.22.1--General. All installations and plants for the manufacture of precast-prestressed bridge members shall be PCI (Prestressed Concrete Institute) Certified. Bridge members manufactured in plants or installations not so approved will not be accepted for use in the work. The Contractor or other manufacturer shall employ a technician skilled in the adopted system of prestressing to supervise the manufacturing operations. This technician shall be certified according to the guidelines of this specification. The Contractor shall develop and implement a Quality Control Program as per Division I of PCI Quality Control Manual, 4th Edition. The Quality Control Program shall be submitted to the District Materials Engineer for approval.

804.03.22.2--Stressing Requirements. The jacks for stressing shall be equipped with accurate calibrated gauges for registering the jacking pressure. Means shall be provided for measuring elongation of strands to at least the nearest 1/16 inch.

Prior to beginning work, the Contractor or manufacturer shall have all jacks to be used, together with their gauges, calibrated by an approved laboratory. All jacks and gauges shall have an accuracy of reading within two percent. The testing agency shall furnish the Engineer a statement certifying that the jacks and gauges meet this requirement. During the progress of the work, if a gauge appears to be giving erratic results or if the gauge pressure and elongations indicate materially differing stresses, recalibration will be required.

Calibration of jacks and gauges shall be repeated at intervals deemed necessary by the Engineer. These intervals for calibration shall not exceed one year.

Shop drawings of prestressed beams, including an erection plan, shall be submitted in duplicate to the Bridge Engineer for approval prior to manufacture of members.

804.03.22.2.1--Methods. Plans for the particular bridge members will show prestressing by one of the following methods:

(A) Pretensioning. The prestressing strands are stressed initially. After the concrete is placed, cured, and has attained the compressive strength shown on the plans, the stress is transferred to the member. The method used for pretensions shall be in accordance to Division V of PCI Quality Control Manual, 4th Edition.

(B) Posttensioning. The posttensioning tendons are installed in voids or ducts and are stressed and anchored after development of the compressive strength specified on the plans. The voids or ducts are then pressure grouted.

(C) Combined Method. Part of the reinforcing is pretensioned and part posttensioned. Under this method all applicable requirements for the two methods specified shall apply to the respective stressing elements being used.

804.03.22.2.2--Alternate Details for Prestressed Members. In the event that the Contractor / Manufacturer desires to use materials or methods that differ in any respect from those shown on the plans or described in these specifications, the Contractor shall submit for approval full plan details on acceptable tracings suitable for reproduction and specifications which shall become the property of the Department. In order for alternate materials and/or methods to be considered, they will be required to comply fully with the following:

- A. Provisions equal to those stipulated in these specifications.
- B. Current AASHTO Specifications.
- C. Recommendations of materials manufacturer.
- D. Camber tolerance of beams and spans shown on plans.

Note: Alternate materials and methods will not be authorized on Federal-Aid Projects.

The Engineer shall be the sole judge as to the adequacy and propriety of any variation of materials or methods.

804.03.22.2.3--Stressing Procedure.

(A) General. Stressing shall be performed by suitable jacks working against unyielding anchorages and capable of maintaining the required stress for an indefinite period without movement or yielding. Strands may be stressed singularly or in a group.

The tension to be applied to each strand shall be as shown on the plans. The tension shall be measured by both jacking gauges and elongations in the strands and the result shall check within close limits.

It is anticipated that there will possibly be a difference in indicated tension between jack pressure and elongation of about five (5) percent. In this event, the discrepancy shall be placed on the side of slight overstress rather than understress.

In the event of an apparent discrepancy between gauge pressure and elongation of as much as five (5) percent, the entire operation shall be carefully checked, and the source of error determined before proceeding further.

Elongation is to be measured after the strands have been suitably anchored, and all possible slippage at the anchorages has been eliminated.

In all stressing operations, the stressing force shall be kept as nearly symmetrical about the vertical axis of the member as practicable.

(B) Pretensioning. All strands to be prestressed shall be brought to a uniform initial tension prior to being given their full pretensioning. This uniform initial tension of approximately 1000 to 2000 pounds shall be measured by suitable means such as a dynamometer so that its value can be used as a check against elongation computed and measured.

After the initial tensioning, the strand or group shall be stressed until the required elongation and jacking pressure is within the limits specified.

When the strands are stressed in accordance with the plan requirements and these specifications and all other reinforcing is in place, the concrete shall be placed in the prepared forms.

Strand stress shall be maintained until the concrete between anchorages has attained the required compressive strength as determined by cylinder tests, after which the strands shall be cut off flush with the ends of column members, and cut as shown on the plans for beams, girders, etc. Strands shall be cut or released in such a manner that eccentricity of prestress will be kept to a minimum and no damage to the member will result. The strand cutting pattern shall be as shown on the plans or as approved by the Bridge Engineer.

(C) Posttensioning. For all posttensioning tendons/bars the anchor plates shall set exactly normal in all directions to the axis of the tendon/bar. Parallel wire anchorage cones shall be recessed within the beams. Tensioning shall not take place until the concrete has reached the compressive strength shown on the plans.

Elongation and jacking pressures shall make appropriate allowance for all possible slippage or relaxation of the anchorage. Posttensioning tendons/bars shall be stressed in the order and manner shown on the plans.

The units shall be tensioned until the required elongations and jacking pressures are attained and reconciled within the limits specified in Subsection 804.03.22.2.3(A) with such overstresses as approved by the Engineer for anchorage relaxation.

Independent references shall be established adjacent to each anchorage to indicate any yielding or slippage that may occur between the time of initial stressing and final release of the strands.

Straight tendons/bars may be tensioned from one end. Unless otherwise specified, curved tendons shall be stressed by jacking from both ends of the tendons.

(D) Combined Method. In the event that girders are manufactured with part of the reinforcement pretensioned and part posttensioned, the applicable portions of the requirements listed herein shall apply to each type.

804.03.22.3--Manufacture.

804.03.22.3.1--Forms. The forms used for precast-prestressed bridge members shall meet the requirements of Division II of the PCI Quality Control Manual, 4th Edition.

804.03.22.3.2--Placing and Fastening Steel. Placing and fastening of all steel used for precast-prestressed bridge members shall meet the requirements of Division V of the PCI Quality Control Manual, 4th Edition.

804.03.22.3.3--Holes for Prestressing Tendons/Bars. Holes provided in girders for prestressing tendons/bars shall be formed by means of inflatable rubber tubing, flexible metal conduit, metal tubing, or other approved means.

804.03.22.4--Placing and Curing Concrete.

804.03.22.4.1--Placing. The placing of concrete shall meet the applicable requirements of Division III of PCI Quality Control Manual, 4th Edition.

804.03.22.4.2--Curing. Initial and accelerated curing of all members shall meet the applicable requirements of Division IV of PCI Quality Control Manual, 4th Edition except for the following listed requirements.

The source of heat for accelerated cure shall be steam. Calibrated thermocouples shall be implanted into the concrete members to monitor areas expected to have maximum and minimum heat. Curing methods and procedures listed in the prestress producer's PCI Quality System Manual shall be approved by the Department before their implementation.

804.03.22.4.3--Removal of Side Forms. Side forms may be removed after the concrete has attained sufficient strength to maintain a true section. In order to obtain "sufficient strength", it may be necessary to cure members for 12 hours or more as prescribed in Subsection 804.03.22.4.2, or to attain a minimum compressive strength of 1,000 psi.

If high-early-strength concrete is obtained by use of low slump (0 to 1.5-inch) concrete, vacuum process, or other approved methods, side forms may be removed earlier; however, approval of the methods and revision from normal

schedules will be made only after inspections by the District and Jackson Laboratories have determined that satisfactory results will be attained by the methods and schedules proposed.

804.03.22.4.4--Grouting. The holes through posttensioned members in which the tendons are installed shall be equipped with approved grouting vents. All prestressing tendons to be bonded shall be free of dirt, loose rust, grease, or other deleterious substances. Before grouting, the ducts shall be free of water, dirt, and other foreign substances. The ducts shall be blown out with compressed air until no water comes through the ducts. For long members with draped tendons an open tap at low points may be necessary. After completion of stressing, the annular space between sides of tendon and sides of hole shall be grouted as set in the following paragraphs.

With the grouting vent open at one end of the core hole, grout shall be applied continuously under moderate pressure at the other end until all entrapped air is forced out through the open grout vent, as evidenced by a steady stream of grout at the vent. Whereupon, the open vent shall be closed under pressure. The grouting pressure shall be gradually increased to a refusal of at least 75 psi and held at this pressure for approximately 10 seconds, and the vent shall then be closed under this pressure.

Portland cement grout shall consist of a mixture of:

- 1 part Type 1 Portland cement
- 1/4 part fly ash
- 3/4 part washed sand *
- 4 to 6 gallons of water per bag of cement.

* all passing No. 16 sieve and not more than 5% retained on No. 30

A plasticizing admixture, subject to approval by the Engineer, shall be used in accordance with the manufacturer's recommendations.

The grout shall be mixed in a mechanical mixer, shall have the consistency of heavy paint, and shall be kept agitated until placed.

Members shall not be moved before the grout has set, ordinarily at least 24 hours at 80°F or higher.

804.03.22.5--Finishing and Marking. Units shall be given a Class 1 finish at the plant and shall be given a Class 2 finish after erection when required.

Recesses in girders at end of diaphragm bars, holes left by form ties, and other surface irregularities shall be carefully cleaned and patched with an approved non-shrink commercial grout or a non-shrinkage mortar of the following composition:

1 part Type 1 cement
1 1/2 to 2 parts fine sand
1/2 to 3/4 ounces aluminum powder per bag of cement
Approved admixture per Subsection 713.02.
Sufficient water to produce a workable but rather stiff mix.

The units shall be clearly marked in accordance with Department SOP.

804.03.22.6--Handling, Storage, and Installation. Posttensioned members may be handled immediately after completion of stressing and grout has set. Pretensioned members may be handled immediately after release of tensioning. In either case, the members shall have developed a minimum compressive strength of 4000 psi prior to handling. In the event stressing is not done in a continuous operation, members shall not be handled before they are sufficiently stressed, as determined by the Engineer, to sustain all forces and bending moments due to handling. In the handling, storage, and transporting of beams or girders, they shall be maintained in an upright position (position as cast) at all times and shall be picked up from points within distance from beam ends equal to beam depth or at pick-up points designated on the plans. Disregard of this requirement and dropping of units may be cause for rejection, whether or not injury to the unit is apparent. Piles shall be picked up and loaded for shipment at points shown by the suspension diagram on the plans. Extreme care shall be used in handling and storing piles to prevent damage. The dropping of a pile may be cause for rejection of same, whether or not there is apparent injury to the member.

Care shall be exercised during the storage, hoisting, and handling of precast units to prevent damage. Damaged units shall be replaced by the Contractor at no additional costs to the State.

When members are stacked for storage, each layer shall be supported at or near the pick-up points. Supports shall be carefully placed in a vertical line in order that the weight of any member will not stress an underlying member. To prevent damage in moving members it is suggested that rigid supports be covered with a cushion of wood or other resilient material.

Members shall not be transported until at least one day after the concrete has reached a compressive strength of 5,000 psi or greater strength when shown on the plans.

Piles used in salt water shall not be driven until concrete is seven days old, and air-entrained concrete shall be used in such piles.

After prestressed concrete voided slab units are set, doweled and bolted in their final position the keyways and dowel holes shall be filled with an approved non-

shrink grout. Traffic shall not be permitted on the spans for 24 hours after grouting, and heavy construction equipment exceeding 15 tons will not be permitted on the spans for a period of 72 hours after grouting.

Adjacent slab units that mismatch more than one-fourth inch shall be adjusted prior to grouting of the shear keys. The maximum deviation from cross-section and grade (exclusive of camber) at any point shall not exceed one-fourth inch; and when the surface is checked with a ten-foot straightedge applied both parallel and perpendicular to the centerline, the variance shall not exceed one-fourth inch.

In addition to the requirements set out in this section, the applicable requirements of Section 803 shall apply.

804.03.22.7--Tolerances for Accepting Precast Prestressed Concrete. Member shall meet the dimension tolerances set by Division VII of PCI Quality Control Manual, 4th Edition.

804.03.22.8--Testing of Materials. Concrete and aggregate testing shall meet the requirements of Division VI of PCI Quality Control Manual, 4th Edition, except that the concrete mix design shall meet the requirements of Subsection 804.02.10 "Portland Cement Concrete Mix Design". Also, in addition to concrete compressive tests samples made for detensioning and 28-day strength, test samples shall be made and tested in order to prove compliance to the requirements of Subsection 804.03.22.6 for handling and shipping prestressed members. Compressive strength test cylinders for detensioning, handling and shipping shall receive the same type curing as the prestressed members for which they represent. Compressive strength samples shall be made each day for each prestress casting bed.

804.03.22.9--Testing Personnel. Technicians testing Portland cement concrete used in the production of precast-prestressed members shall be PCI Quality Control Technician/Inspector Certified. Each producer of precast-prestressed members shall have at least one PCI Level II certified technician on site during production for Department projects.

804.03.22.10--Documentation. The Precast-Prestressed Producer for each Precast-Prestressed concrete bridge member shall maintain documentation as set forth in Department SOPs. Testing and inspection record forms shall be approved by the Central Laboratory and as a minimum contain information listed in Division VI of PCI Quality Control Manual, 4th Edition.

804.03.22.11--Use in the Work. Before any Precast-Prestressed member is incorporated into the work, documentation as described in Subsection 804.03.22.10 is required along with visual inspection of the member at the bridge construction site. Project Office personnel as per Department SOP will make visual inspection of the prestressed member at the bridge construction site.

804.04--Method of Measurement. Concrete, complete and accepted, will be measured in cubic yards. The concrete volume will be computed from the neat dimensions shown on the plans, except for such variations as may be ordered in writing by the Engineer. The quantity of concrete involved in fillets, scorings, and chamfers one square inch or less in cross-sectional area will be neglected. Deductions shall be made for the following:

- (1) The volume of structural steel, including steel piling encased in concrete.
- (2) The volume of timber piles encased in concrete, assuming the volume to be 0.80 cubic foot per linear foot of pile.
- (3) The volume of concrete piles encased in concrete.

No deduction will be made for the volume of concrete displaced by steel reinforcement, floor drains, or expansion joint material that is one inch or less in width normal to the centerline of the joint. Where railing is bid as a separate item, that portion of the railing above the top of the curb, above the surface of the sidewalk, or above the bridge roadway, as the case may be, will not be included in the measurement of concrete, but will be measured as railing. Massive pylons or posts which are to be excepted from payment for railing and are intended to be measured for as concrete will be so noted on the plans.

When shown on the plans or directed by the Engineer, concrete placed as a seal for cofferdams will be measured by the cubic yard actually in place, except that no measurement will be made of seal concrete placed outside of an area bounded by vertical planes 18 inches outside the neat lines of the footing as shown on the plans or as directed and parallel thereto.

Reinforcing steel will be measured and paid for in pounds as set out in Section 805.

Unless otherwise specified, structural steel will be measured and paid for as set out in Section 810.

Excavation for bridges will be measured and paid for as in Section 801.

Piling will be measured and paid for as set out in Sections 802 and 803.

Railing will be measured and paid for as set out in Section 813.

Prestressed concrete beams and plank will be measured by the linear foot.

Prestressed concrete voided slab units, interior and exterior with railing, and precast concrete caps, intermediate and end cap with winged abutment wall, of the size and type specified will be measured by the unit complete in place and accepted. Railing, winged abutment walls, grout, tie rods, nuts, washers, bearing pads and other appurtenances will not be measured for separate payment.

804.05--Basis of Payment. Concrete will be paid for at the contract unit price per cubic yard for the class or classes specified, complete in place. Prestressed concrete beams and plank will be paid for at the contract unit per linear foot of specified size and type.

Prestressed concrete voided slab units and precast caps will be paid for at the contract unit price per each for the specified types and sizes, complete in place and accepted; which price shall be full compensation for furnishing, hauling and erecting the members; including all prestressing reinforcement and other reinforcement in the members. Payment at the contract unit prices bid shall be full compensation for furnishing all materials, equipment, tools, labor and incidentals necessary to complete the work.

Payment will be made under:

- 804-A: Bridge Concrete, Class _____ - per cubic yard
- 804-B: Box Bridge Concrete, Class _____ - per cubic yard
- 804-C: Length Prestressed Concrete Beam, Type _____ - per linear foot
- 804-D: Length Prestressed Concrete Plank - per linear foot
- 804-E: Length Prestressed Concrete Voids Slab,
Size Interior - per each
- 804-F: Length Prestressed Concrete Voids Slab,
Size Exterior - per each
- 804-G: Length Precast Concrete Caps, End Unit with Wall - per each
- 804-H: Length Precast Concrete Caps, Intermediate Unit - per each

SECTION 805 - REINFORCEMENT

805.01--Description. This work consists of furnishing and placing steel reinforcement for bridges in accordance with these specifications and in reasonably close conformity with the dimensions, bending, spacing, and other requirements shown on the plans.

805.02--Materials. Materials used shall conform to the requirements of Section 711.

Supports for bar reinforcement shall meet the requirements of Subsection 711.02.7.

805.02.1--Order Lists. Before ordering reinforcement, all order lists and bending diagrams shall be furnished by the Contractor for the approval of the Engineer, and no materials shall be ordered until the lists and bending diagrams have been approved. All expense incident to the revision of material furnished in accordance with such lists and diagrams to make it comply with the design drawings shall be borne by the Contractor.

805.03--Construction Requirements.

805.03.1--Protection of Material. Steel reinforcement shall be protected at all times from damage. Damaged material will not be approved for use in the work. When placed in the work and immediately prior to placing the concrete, the reinforcement shall be free from dirt, oil, paint, grease, and other foreign substances and shall be free of loose or thick rust or millscale which could impair bond of the steel with the concrete.

805.03.2--Fabrication. Bent bar reinforcement shall be cold bent to the shapes shown on the plans, and unless otherwise provided on the plans or by authorization, bends shall be made in accordance with Subsection 711.02. Bars partially embedded in concrete shall not be field bent except as shown on the plans or permitted.

Bar reinforcement shall be bundled, tagged and marked in accordance with Code of Standard Practice of the Concrete Reinforcing Steel Institute.

805.03.3--Placing and Fastening. Reinforcement shall be accurately placed in the positions shown on the plans and firmly held during the placing and setting of concrete. Bars shall be tied at all intersections; except where spacing is less than one foot in each direction, alternate intersections shall be tied.

Distances from the forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports. Blocks for holding reinforcement from contact with the forms shall be precast mortar blocks of approved shape and dimensions or metal chairs, reference Subsection 711.02.7. Layers of bars shall be separated by precast mortar blocks or by other equally suitable devices. The use of pebbles, pieces of broken stone or brick, metal pipe, and wooden blocks will not be permitted. The clear distance between parallel bars, except in columns and between multiple layers of bars in beams, shall not be less than the nominal diameter of the bars, $1 \frac{1}{3}$ times the maximum size of the coarse aggregate, nor one inch.

Where reinforcement in beams or girders is placed in two or more layers, the clear distance between layers shall not be less than one inch, and the bars in the upper layers shall be placed directly above those in the bottom layer.

In spirally reinforced and in tied columns, the clear distance between longitudinal bars shall not be less than $1\frac{1}{2}$ times the bar diameter, $1\frac{1}{2}$ times the maximum size of the coarse aggregate, nor $1\frac{1}{2}$ inches.

The clear distance between bars shall also apply to the clear distance between a contact splice and adjacent splices or bars.

Reinforcement in any member shall be inspected and approved by the Engineer before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and removal and replacement of concrete and reinforcement required.

If fabric reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

805.03.4--Splicing of Bars. All reinforcement shall be furnished in the full lengths indicated on the plans. Splicing of bars, except when shown on the plans, will not be permitted without the written approval of the Engineer. Splices shall be staggered insofar as possible.

The minimum distance to the surface of the concrete shall be as specified on the plans. Reinforcement shall not be welded except if detailed on the plans or if authorized by the Engineer in writing. Welding shall conform to the current AWS specifications for Recommended Practices for Welding Reinforcement Steel, Metal Inserts, and Connections in Reinforced Concrete Construction.

805.03.5--Lapping of Mesh or Mats. Sheets of mesh or bar mat reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than one mesh in width.

805.03.6--Substitutions. Substitutions of different size bars will be permitted only with specific authorization by the Engineer. If steel is substituted, it shall have an area equivalent to the design area or larger.

805.03.7--Epoxy Coated Bars.

805.03.7.1--Repair of Damaged Epoxy Coating. When required, damaged epoxy coating shall be repaired with patching material conforming to ASTM Designation: A 775. Repair shall be done in accordance with the patching material manufacturer's recommendations.

805.03.7.2--Handling of Epoxy Coated Bars. The Contractor shall use padded or non-metallic slings and padded straps to protect the coated reinforcement from damage. The bundled bars shall not be dropped or dragged and must be stored on wooded cribbing. If, in the opinion of the Engineer, the coated bars or plates have been damaged as a result of the Contractor's negligence, the material will be rejected. The Contractor may propose, for the approval of the Engineer, alternate precautionary measures.

805.03.7.3--Placing of Epoxy Coated Bars. Epoxy-coated reinforcing bars supported from formwork shall rest on coated wire bar supports, or on bar supports made of dielectric material or other acceptable materials. Wire bar supports shall be coated with dielectric material for a minimum distance of two inches from the point of contact with the epoxy-coated reinforcing bars. In walls having reinforcing bars, spreader bars where specified by the Engineer shall be epoxy coated. Proprietary combination bar clips and spreaders used in walls with epoxy-coated reinforcing bars shall be made of corrosion resistant material. Epoxy-coated reinforcing bars shall be fastened with nylon-, epoxy-, or plastic-coated tie wire or other acceptable materials.

805.04--Method of Measurement. Steel reinforcement incorporated in bridge concrete and accepted will be measured in pounds based on the total computed weight for the sizes and lengths of bars, mesh or mats shown on the plans or authorized. Reinforcement for box bridge concrete will be measured and paid for in accordance with Section 602.

Epoxy coated reinforcement bars, not included in other pay items, will be measured in pounds based on the computed weight from the theoretical weight of plain round bars of the same nominal size as shown in the table of areas and masses in Section 711.

The weight of mesh will be computed from the theoretical weight of plain wire. If the weight per square foot is given on the plan, that weight will be used.

The weight of plain or deformed bars, or bar mat, will be computed from the theoretical weight of plain round bars of the same nominal size as shown in the table of area and weights in Section 711.

The weight for payment of structural steel reinforcement, incorporated in the work and accepted, will be the theoretical weight of the material used.

The weight of reinforcement used in railings measured on a linear foot basis will not be measured. The weight of reinforcement in precast piles and other items where the reinforcement is included in the contract price for the item will not be measured.

No allowance will be made for clips, wire, separators, wire chairs, and other material used in fastening the reinforcement in place. If bars are substituted upon

the Contractor's request and as a result more steel is used than specified, only the bars specified will be measured.

When splices, other than those shown on the plans, are made for the convenience of the Contractor, the extra steel will not be measured.

805.05--Basis of Payment. Reinforcement will be paid for at the contract unit price per pound, which shall be full compensation for completing the work.

Payment will be made under:

- 805-A: Reinforcement - per pound
- 805-B Reinforcement, Epoxy Coated - per pound

**SECTION 806 - PRECAST CONCRETE BRIDGE
CAPS, SPANS AND WINGS**

806.01--Description. This work consists of furnishing and installing precast concrete caps, precast concrete spans complete with post, bridge railing or concrete barrier rail and precast wings for bridges in accordance with these specifications and all in reasonably close conformity with the dimensions and design indicated on the plans and placed on a prepared substructure to the lines and grades established by the Engineer.

806.02--Materials. The materials used in this construction, in addition to the general requirements of these specifications, shall conform, unless otherwise stipulated, to the requirements prescribed in Division 700, Material and Tests, for the particular kind and type of material specified.

806.02.1--Sampling and Testing. As referenced in Subsection 106.03, approval of the source of supply of cement, fine and coarse aggregate, water, reinforcement and other materials used in the construction of the caps, slabs and wings and the results of tests showing their suitability for use shall be obtained prior to their use in any construction. Samples shall be submitted as directed.

The Contractor/Manufacturer without extra compensation, shall supply the Engineer's representative, plant inspector, with the necessary materials and representative concrete mix for making a minimum of one test cylinder of concrete for each seven caps, slabs, or wings or a minimum of one test cylinder per day if less than seven caps, slabs, or wings are constructed. Other test cylinders may be required by the Engineer to establish strength for handling slabs or caps. Cylinders are to be cured with the same method used in curing the caps, slabs, or wings, as the case may be. Only those caps, slabs, or wings bearing identification marks of acceptance by the Department or approved laboratories

will be permitted for use in the construction. The acceptance of any precast concrete member at the production plant shall in no way be final and further inspection will be made at the structure site before and after the member has been placed in its final position.

806.03--Construction Requirements.

806.03.1--General. The methods of construction shall conform, unless otherwise stipulated, to the provisions and requirements prescribed in these specifications and indicated on the plans for the several items which constitute the complete structure.

806.03.2--Substructure. The substructure shall be constructed in conformity with Section 803 and as indicated on the plans. Payment for same will be made under Section 803, unless otherwise indicated.

The piles shall be so driven that the cap may be placed in its proper location without excessive manipulation of the piles.

806.03.3--Precast Caps, Slabs, and Wings.

806.03.3.1--Proportioning and Mixing Concrete. The composition, proportioning and mixing of the concrete used in this construction shall be as specified in Section 804, Concrete Bridges and Structures, and shall be the class concrete specified on the plans.

806.03.3.2--Reinforcing Steel. Reinforcing steel shall be of the quality, type, and size specified on the plans and placed as indicated. It shall meet the requirements set out in Subsection 711.02, as applicable.

Separate payment will not be made for reinforcing steel.

806.03.3.3--Forms. All forms shall be of metal or wood. They shall be built mortar-tight and of sufficient rigidity to prevent any distortion due to pressure of the concrete and other loads incident to the construction operations. The forms shall be substantial and unyielding and shall be so designed that the finished concrete will conform to the proper dimensions and contours. The design of the forms shall take into account the effect of vibration of concrete as it is placed.

Forms shall be filleted at all sharp corners and shall be given a bevel or draft in the case of all projections to ensure easy removal.

All forms shall be set and maintained true to the lines designated until the concrete is sufficiently hardened or for periods as hereinafter specified.

Forms shall be treated with oil immediately before placing concrete in them. Any material which will adhere to, or discolor, the concrete shall not be used. Extreme care shall be exercised to make sure that no oil gets on the reinforcing steel.

806.03.3.4--Handling and Placing Concrete. Prior to the placing of any concrete, the forms shall be thoroughly cleaned of any construction debris and extraneous matter and the reinforcing bars of the size and type indicated placed and secured in the forms as indicated on the plans. Concrete shall not be deposited in the forms until the inspector has checked the placing of the reinforcement and has given approval to proceed.

Ready mix concrete transported in a truck mixer or truck agitator shall be discharged at the site of the work and placed in its final position in the forms within one hour after the introduction of the mixing water to the cement and aggregate or the cement to the aggregate whichever occurs first; except that in abnormal weather, or under other conditions contributing to the quick stiffening of the concrete, the Engineer may make a determination of a lesser time for placement considering all factors affecting initial set of the concrete. When mixed concrete is transported in approved non-agitating trucks, the concrete shall be discharged at the work site within thirty minutes after the introduction of the mixing water to the cement and aggregate.

The concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. Open troughs and chutes used shall be of metal or metal lined and shall be kept clean and free from coating of hardened concrete by flushing with water after each pour. Water used for flushing shall be discharged clear of the cap, slab, or wing forms.

806.03.3.5--Compaction. Concrete for the caps, slabs, and wings during and immediately after depositing shall be thoroughly compacted by the use of vibrators and suitable spading tools. Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibration shall be internal and shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued so as to cause segregation. Vibration shall not be continued at any one point to the extent that localized areas of grout are formed.

The entire operation of depositing and consolidating the concrete shall be so conducted that the concrete shall be smooth, dense and free from any honeycomb or pockets of segregated aggregates. The roadway surface of slabs and tops of caps and wings shall be finished with a wood float.

Concrete in the precast caps, slabs and wings shall be placed in one continuous operation for each cap, slab, and wing.

806.03.3.6--Placing Bolts, Drains, Bolt Holes, etc. All bolts, drains, bolt holes, etc., indicated on the plans as necessary or desirable shall be placed in the concrete at the locations indicated on the plans. They shall be formed by approved methods and operations and shall be such as to ensure proper connections.

806.03.3.7--Removal of Forms and Curing. Side forms for precast concrete bridge caps, slabs and wings may be removed after the concrete has attained sufficient strength to maintain a true section. The minimum time for removal, using alternate types of curing, is considered to be as follows:

With a minimum of three thicknesses of wetted burlap, cotton mats, or constant fogging with temperatures of more than 40°F and less than 80°F -- 24 hours; with temperatures 80°F and higher -- 20 hours.

Steaming in enclosures at temperatures of not less than 80°F and not more than 150°F -- 12 hours.

When Type III Cement is permitted, side forms may be removed after 12 hours using all types of curing.

Bottom forms shall remain in place until the concrete has obtained a minimum compressive strength of 2,500 psi as determined by cylinder tests. When the caps, slabs, or wings are moved, they shall be deposited directly on a level hard-surfaced true-plane area without stacking and shall remain undisturbed for seven days beyond the period of initial handling while the curing continues.

Caps, slabs and wings shall be covered with wetted burlap immediately after the finishing operations.

Liquid membrane curing may be used, but shall be white pigmented and applied at the rate of not less than one gallon per 150 square feet of surface. The entire surface and exposed edges shall be sprayed with the membrane as soon as practicable after finishing is complete and as side forms are removed. The seal shall be applied to the surface as a fine mist which shall provide a continuous, uniform, water impermeable film. The bottom of the caps, slabs, or wings shall be sealed with the membrane when they are removed from the bottom supporting forms.

The Contractor may use steam curing provided the Engineer has given written approval prior to casting operations. Steam curing shall be according to stipulations set out in Subsection 804.03.22.4.2.

The cap, slab, wing and rail units shall not be shipped until the concrete has obtained the specified minimum compressive strength as determined by cylinder

tests and shall be cured for a minimum of 14 or 21 days as indicated in the table below:

Compressive Strength Specified PSI	Requirements Prior to Shipment	
	Minimum Curing Days	Minimum Compressive Strength PSI
3000	14	3000
4000	21	4000
5000	21	5000

806.03.4--Tolerance of Dimensions.

806.03.4.1--Caps. The width and length of the caps shall not vary more than one-quarter inch from the plan dimensions. The bottom of the cap shall be smooth and shall not vary more than one-eighth of an inch when tested with a straightedge in a horizontal direction for any ten-foot length. The top of the caps shall not vary more than one-sixteenth inch from the slope shown on the plans.

806.03.4.2--Slabs. The four sides of the slab shall not vary more than one-eighth inch for the full depth of the slab when tested with a straightedge in a vertical direction, nor more than one-quarter inch in the full length of the slab when tested with a straightedge in a horizontal direction, nor shall the top of the slab vary more than one-eighth inch in any ten-foot length.

806.03.4.3--Wings. The width and length of the wings shall not vary more than one-quarter inch from the plan dimensions.

806.03.4.4--Concrete Barrier Rail. The width of the rail shall not vary more than one-eighth inch and the length shall not vary more than one-quarter inch. The sides shall be smooth with no discolorations. In the event patching is required, the entire rail shall be given a Class 2 finish.

806.03.5--Handling and Placing Precast Caps, Slabs, Barrier Rail and Wings. The precast caps, slabs, barrier rail, and wings shall be handled in such a manner that they will not be subjected to excessive and undue abuse producing crushing, spalling, or undue marring of the concrete. Injury to units may be cause for rejection whether the injury to the unit is apparent or not. Damaged units shall be replaced by the Contractor at no additional costs to the State.

Where the caps, slabs, barrier rail, and wings are to be loaded or stored in tiers, the blocking between the tier should be in a vertical plane so that the weight of the upper caps, slabs or wings cannot produce bending in those of a lower tier.

After the caps are set and doweled, welded, or grouted to the piling, the dowel holes shall be filled with grout or AC-13 before the slabs are set.

Each section or unit shall be placed as closely as possible to its final position in the structure so that the use of bars or other tools which might mar the concrete will be eliminated. The abutting edges of each slab unit shall be carefully cleaned of any concrete or extraneous matter in order that the longitudinal joints may be bolted tightly together.

After the slab units are set, doweled and bolted in their final position the keyways and dowel holes shall be filled with an approved non-shrink grout. Traffic shall not be permitted on the spans for 24 hours and heavy construction type traffic, or other loads exceeding 15 tons, will not be allowed on the spans for a period of 72 hours after grouting. When epoxy grout is allowed, these time requirements may be reduced to 12 hours. When a non-shrink commercial grout is used the 72 hours time requirement may be reduced to 24 hours.

Expansion material shall be placed between all bearing points of the slabs and surfaces of the caps. When not otherwise specifically provided, three layers of No. 15, Type I, roofing felt shall be used.

806.03.5.1--Transverse Joints. When a bridge consists of more than one span, bituminous premolded joint filler, one-quarter inch in thickness, shall be placed in the joint between spans. This joint filler shall be for the full thickness of the concrete, less one inch at the top of the slab, and for the full width of the structure, including curb. When the spans are completely in place and bolted the transverse joints shall be sealed with AC-13 or other joint sealer approved by the Engineer.

806.03.5.2--Railing. The bridge railing shall be installed after all other work on the bridge has been completed.

The material used shall meet the dimensions and requirements specified on the plans and the railing shall be constructed in conformity with the details indicated and to the lines and grades established.

806.04--Method of Measurement. Precast concrete slab units either interior or curb units, precast barrier rail units and precast concrete caps either intermediate or end bent with winged abutment wall of the size and type specified will be measured by the unit per each.

Winged abutment walls, grout, tie rods, nuts, washers, bearing pads and other appurtenances will not be measured for separate payment.

806.05--Basis of Payment. Precast concrete slab units, precast barrier rail units and precast concrete caps will be paid for at the contract unit price per each for

the specified types and sizes. This price shall be full compensation for furnishing all materials, hauling and erecting, equipment, tools, labor and incidentals necessary to complete the work.

Payment will be made under:

806-A: ____' Precast Concrete Slab Units, ____' Interior	- per each
806-B: ____' Precast Concrete Slab Units, Curb	- per each
806-C: ____' Precast Barrier Rail Units	- per each
806-D: ____' Precast Concrete Caps, Intermediate Unit	- per each
806-E: ____' Precast Concrete Caps, End Unit with Wall	- per each

SECTION 808 - JOINT REPAIR

808.01--Description. All joints requiring repair shall be reconstructed with specified materials according to details shown on the plans and instructions contained herein. All other requirements shall be in accordance with the applicable provisions of Sections 501 and 804 of the Standard Specifications.

808.02--Materials.

808.02.1--General. When materials from the Department's current list of approved materials are to be used, the Contractor shall submit documentation to the Engineer that the epoxy and all components meet the requirements of the contract.

If the materials proposed for use are not from the Department's current list of approved materials, a sample of the epoxy and all components required for the epoxy mortar mix shall be submitted to the Engineer for evaluation and approval at least 30 calendar days prior to placement.

Subsequent approval of each new lot may be by certification. The manufacturer must certify that the new lot of material is the same composition as that originally approved by the Department and that the material has not been changed or altered in any way.

A representative of the epoxy manufacturer must be present for sufficient time to assure that the Contractor is properly schooled in the use of the epoxy materials.

808.02.2--Epoxy Resin. The material shall meet the requirements of ASTM Designation: C 881, Type I, Grade 2, Class C.

808.02.3--Silica Sand. The material shall be bagged general purpose blast cleaning sand.

808.02.4--Epoxy Mortar Mix. The mortar mix shall consist of one part liquid epoxy to 3.5 parts clean dry sand by volume.

808.02.5--Mixing and Curing. Mixing of all epoxy materials shall be accomplished with a mechanical mixer.

A trial batch of mortar, approximately one cubic foot, will be mixed and used for joint repair. From this batch, the pot life and subsequent amount of material to be mixed will be determined.

Workers should wear rubber gloves and any other protective measures necessary to minimize contact with skin, eyes, etc.

The curing time shall be regulated so the repaired area may be open to traffic in four hours from time of placement.

To meet the above requirement, it may be necessary to store materials in heated enclosures and provide temporary cover and heat to the repaired area.

808.03--Construction Details. All repair areas are to be thoroughly cleaned by chipping and sandblasting to sound concrete.

To form joints, insert styrofoam or other approved forming materials to desired grade. Forms are to be greased lightly to assist in removal.

The mortar mix shall be prepared and placed during periods of warm weather if at all possible.

The prepared surface shall be lightly primed with neat epoxy prior to placement of the mortar mix.

Placement of the mortar mix shall start at the earliest practical time and may continue until approximately four and one-half hours prior to opening the section of roadway or bridge to traffic.

The mortar mix shall be finished to the line of the existing joint and to the grade of the adjacent pavement or bridge deck.

After final finish of the mortar mix, the surface shall be sprinkled with sand to provide texture. Excess sand to be hand broomed from surface after mortar has set.

Acetone alcohol may be used to clean and lubricate trowels to assist with the surface finishing.

808.04--Method of Measurement. When specified for payment, joint repair will be measured by the linear foot for joint preparation and by the gallon for the mortar mix. When the mortar mix consist of epoxy and sand, the volume of measurement for the mortar mix will be determined from the summation of the volumes of the epoxy components; and the volume of sand will not be measured for payment.

808.05--Basis of Payment. The accepted quantities of joint repair will be paid for at the contract unit price per linear foot for joint preparation and per gallon for the mortar mix, which price shall be full compensation for furnishing and placing all materials including sand and forming materials and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. No payment will be made for the sand used in the epoxy mortar mix. The price bid for each item of work shall include the cost of continuous maintenance of traffic and protective services as required by the Department's Traffic Control Plan. This shall include all required individual traffic control devices. Payment will be made under:

- 808-A: Joint Preparation - per linear foot
- 808-B: Kind Mortar Mix - per gallon

SECTION 809 - RETAINING WALL SYSTEMS

809.01--Description. This work shall consist of designing and installing one of the retaining wall systems described herein in accordance with the lines, grades and dimensions shown in the plans and specifications.

809.01.1--General. Retaining wall systems shall comply with all material, fabrication and construction requirements found in the Standard Specifications and the construction plans. The submitted retaining wall system shall be as shown in the plans or consist of one of the following three types: Conventional Cantilevered Gravity Wall, Mechanically Stabilized Earth Wall (MSEW), or Precast Gravity Wall. All costs associated with the design and construction of the wall system selected by the Contractor shall be included in the bid price for the wall. The Contractor may select different wall types for different sites, as provided for on the plans.

In the event a MSEW System is chosen, the wall system supplier shall have submitted their system to the Highway Innovative Technology Evaluation Center (HITEC) for review and shall have had a formal evaluation completed for all components of the wall system. The wall system is considered to be the wall

facing and the associated geosynthetic or steel soil reinforcement. Three copies of HITEC's final evaluation report for the chosen MSEW System shall be included with the initial design submittal.

The time required for preparation and review of wall shop drawings shall be charged to the allowable contract time. No additional compensation will be made for any additional material, equipment, or other items found necessary to comply with the project specifications as a result of review by the Department. All submittals shall be submitted to the Bridge Engineer for approval prior to construction.

The retaining wall system shall follow the lines, grades, and location as shown in the plans. In the event that plan dimensions are revised due to field conditions or other reasons, the Contractor shall be responsible for revising the wall plans, design calculations, and summary of quantities.

809.01.2--Submittals.

809.01.2.1--Initial Design Submittal. The initial design submittal shall include three sets of wall plans and three sets of design calculations and notes. The wall plans and design calculations and notes shall clearly state the wall type chosen. The wall plans and design calculations will be returned to the Contractor within thirty (30) calendar days of receipt. All final design calculations and plans shall be prepared, stamped and signed by a Professional Engineer licensed to practice in the State of Mississippi. The calculations shall include, but not be limited to, those items listed below. The designer/supplier furnishing the plans and calculations for the wall system proposed shall be responsible for the internal and external stability of the wall system.

The drawings shall include all details, dimensions, quantities and cross-sections necessary to construct the wall. Prints of the original cross sections will be available to purchase with plans. The wall system plans shall include, but not be limited to, the following items:

1. A plan and elevation sheet or sheets for each wall shall contain the following:
 - a) The elevation view of the wall which shall indicate the elevation at the top of the wall, at all horizontal and vertical break points, and at least every 50 feet along the wall, elevations at the top of leveling pads and footings, and the original and final ground line.
 - b) The plan view of the wall shall show the offset from the construction centerline to the face of the wall at all changes in horizontal alignment. Also included should be the limits of the soil reinforcement, if required, and any drainage structures or pipes lying behind or extending through or under the wall.

- c) General notes required for construction of the wall.
 - d) All horizontal and vertical curve data affecting the wall shall be included.
 - e) A list of all required materials and the required quantity of each shall be provided on the elevation sheet of each wall.
2. All bar bending details shall be included.
 3. All details for foundations and leveling pads shall be shown including steps in the footings or leveling pads. Foundations and leveling pads shall have a minimum cover of two feet.
 4. All panels, modular blocks, coping, and lagging shall be detailed. The details shall include all dimensions necessary to construct the element.
 5. Details should be included for the walls around any existing drainage facilities.
 6. All details concerning the appearance of the wall face shall be included.

Three sets of wall plans shall be submitted with the initial submittal. The plans that are submitted with the initial design submittal shall be prepared on standard 24-inch by 36-inch sheets. Each sheet shall have a title block in the lower right hand corner. The title block shall include the sheet number of the drawing, type of wall designated, the project number, and the Contractor.

The initial design submittal shall include a set of design calculations and notes for the wall(s). Three sets of design calculations and notes shall be submitted. The design calculations and notes shall contain the project number, type of wall designated, date of preparation, and the name of the designer. The package shall have a clear index outlining the design notes and shall include an explanation of the design procedure, explanation of any symbols, and technical documentation of any computer programs used. The design calculations shall clearly state the factors of safety for sliding, pullout, and overturning. In addition, the bearing pressures beneath the wall footing used in the calculations shall be noted.

809.01.2.2--Final Plan Submittal. All final construction plans shall be submitted on 24-inch by 36-inch reproducible mylar sheets. In addition the plans shall be accompanied by either 3½-inch HD floppies or Compact Disks containing the plans in Tagged Image File Format (TIFF) for archive purposes. The final construction plans shall reflect all changes made on the plans submitted for the design submittal.

809.01.3--Design Criteria. The design for any proposed wall shall consider the internal and external stability of the wall including the bearing pressure, overturning and sliding. The design shall consider lateral earth pressures,

including any applicable surcharge loads. In addition, the following general guidelines shall be followed.

- 1. The chosen wall system shall be designed in accordance with the current version of the *AASHTO Standard Specifications for Highway Bridges*.
- 2. Prior to the design of the wall system, the designer/supplier shall be required to perform an in-house geotechnical review of the available geotechnical information with the Geotechnical Branch of Materials Division. The purpose of the geotechnical review will be to obtain the pertinent design information relating to global stability as well as answer questions concerning any of the geotechnical information provided in the plans. The final design shall take into account any global stability issues that are brought forth by the geotechnical review. A generic analysis for global stability will be conducted by the Department and the results provided to the Retaining Wall System Designer at the geotechnical review. Any allowed changes to the wall lines and grades or stabilized soil mass that affect the global stability calculations will require the wall supplier to include a global stability analysis with the final design. The Geotechnical Engineer may be contacted to schedule an appointment.
- 3. The minimum factors of safety to be used in design are as listed below.
 - a. External Stability
 - Sliding 1.5
 - Overturning 2.0
 - Eccentricity, e, at Base $\leq L/6$ for MSEW, where L is the length of the reinforced soil mass
 - Bearing Capacity 2.5
 - Temporary Slopes 1.2
 - Global Stability 1.4, as noted above
 - b. Internal Stability
 - Pullout Resistance for MSEW 1.5
- 4. The wall design shall take into account all appurtenances behind, in front of, under, mounted upon, or passing through the wall and supply the appropriate construction details. These items should be accounted for in the internal and external stability calculations.
- 5. Leveling pads, foundations, or footings shall have a minimum cover of two feet. For design purposes, passive pressure in front of the wall shall be assumed to be zero.

- 6. The front face of the wall may be battered into the slope to improve stability as long as this does not interfere with other project appurtenances such as drainage features or right-of-way.
- 7. The wall design shall provide positive drainage behind the wall to assure that the backfill material remains in a drained condition.
- 8. Where geogrid is to be used for MSEW structures as the soil reinforcement, the following design criteria should be followed.
 - a) The allowable tensile load (T_A) shall be calculated using the following equation and be based on a 100 year design life. The variables used in the equation shall be as allowed by AASHTO or as demonstrated with supporting data in the HITEC evaluation.

Allowable Design Strength of Geogrid:

$$T_A = \frac{T_{CR}}{FS_{ID} \times FS_D \times FS_{UN}}$$

Where:

T_A

=

Maximum Design Strength

T_{CR}

=

Creep Limited Strength

FS_{ID}

=

Factor of Safety For Installation Damage

FS_D

=

Factor of Safety For Durability

FS_{UN}

=

Factor of Safety For Uncertainties

- b) The maximum design tensile load of the geogrid shall not exceed the laboratory tested ultimate strength of the geogrid/facing unit connection divided by a factor of safety of 1.5. The connection strength testing and computation procedures shall be in accordance with AASHTO and demonstrated in the HITEC evaluation.

809.02--Materials. Material requirements will vary depending on the type of wall system chosen. Specific material requirements for each wall type are given below.

809.02.1--Conventional Cantilevered Gravity Wall. Concrete for conventional cantilevered gravity walls shall meet the requirements for Class “AA” concrete as set forth in Section 804 of the Standard Specifications. Reinforcing steel shall conform to the requirements set forth in Subsection 711.02 of the Standard Specifications. Driven Piles shall meet the requirements set forth in Sections 803 and 804.

Unless otherwise indicated on the plans, the exposed concrete surfaces of the wall shall have a Class “2” finish as defined in Section 804.

809.02.2--Mechanically Stabilized Earth Walls (MSEW). Materials for Mechanically Stabilized Earth Walls shall meet the following minimum standards.

809.02.2.1--Precast Concrete Facing Panels. Precast concrete facing panels shall be fabricated in accordance with Section 804 with the following exceptions and additions.

1. Concrete for the precast concrete facing panels shall conform to Class “AA” concrete.
2. Section 804 is supplemented by the following: The units shall be fully supported until the concrete reaches a minimum compressive strength of 1,000 psi. The units can be shipped after reaching a minimum compressive strength of 3,000 psi. At the option of the Contractor, the units may be installed after the concrete reaches a minimum compressive strength of 3,400 psi.
3. Unless otherwise indicated on the plans, the concrete surface for the front face shall have a Class “1” finish as defined in Section 804 of the Specifications and the rear face a uniformed surface finish. The rear face of the panel shall be screeded to eliminate open pockets of aggregate and surface distortions in excess of 1/4 inch. The panels shall be cast on a flat area. The soil reinforcing strips or other galvanized attachment devices used to attach the precast concrete facing panel to the soil reinforcement shall not contact or be attached to the face panel reinforcement steel.
4. The date of manufacture, the production lot number, and the piece mark shall be clearly scribed on an unexposed face of each panel.
5. All units shall be handled, stored, and shipped in such a manner as to eliminate the dangers of chipping, discoloration, cracks, fractures, and excessive bending stresses. Panels in storage shall be supported on firm blocking to protect the panel connection devices and the exposed exterior finish.
6. All units shall be manufactured within the following tolerances:
 - a) Panel Dimensions – Position of the panel connection devices shall be within one inch. All other dimensions shall be within 3/16 inches.

- b) Panel Squareness – Squareness shall be determined by the difference between the two diagonals and shall not exceed 1/2 inches.
- c) Panel Surface Finish – Surface defects on smooth formed surfaces measured over a length of five feet shall not exceed 1/8 inch. Surface defects on the textured-finish surfaces measured over a length of five feet shall not exceed 5/16 inch.

7. Section 804 of the Specifications will be modified as follows.

Acceptance of concrete panels with respect to compressive strength will be determined on the basis of production lots. A production lot is defined as a group of panels that will be represented by a single compressive strength sample and will consist of either 40 panels or a single day's production, whichever is less.

During the production of the concrete panels, the manufacturer will randomly sample the concrete in accordance with AASHTO Designation: T 141. A single compressive strength sample, consisting of a minimum of four cylinders, will be randomly selected for every production lot.

Compression tests shall be made on standard 6-inch by 12-inch test specimen prepared in accordance with AASHTO Designation: T 23. Compressive strength testing shall be conducted in accordance with AASHTO Designation: T 22.

Air content will be performed in accordance with AASHTO Designation: T 152 or AASHTO Designation: T 196. Air content samples will be taken at the beginning of each day's production and at the same time as compressive samples are taken to insure compliance with the specifications. The slump will be determined at the beginning of each day's production and at the same time as the compressive samples are taken.

For every compressive strength sample, a minimum of two cylinders shall be cured in accordance with AASHTO Designation: T 23 and tested at 28 days. The average compressive strength of these cylinders, when tested in accordance with AASHTO Designation: T 22, will provide a compressive strength test result which will determine the compressive strength of the production lot.

If the Contractor wishes to remove forms or ship the panels prior to 28 days, a minimum of two additional cylinders shall be cured in the same manner as the panels. The average compressive strength of these

cylinders when tested in accordance with AASHTO Designation: T 22 will determine whether the forms can be removed or the panels shipped.

Acceptance of a production lot will be made if the compressive strength test result is greater than or equal to 4,000 psi. If the compressive strength test result is less than 4,000 psi, then the acceptance of the production lot will be based on its meeting the following acceptance criteria in its entirety:

- a) 90% of the compressive strength test results for the overall production exceeds 4,150 psi
- b) The average of any six consecutive compressive strength test results exceeds 4,250 psi
- c) No individual compressive strength test result falls below 3,600 psi

Units shall be rejected because of failure to meet any or all of the requirements specified above. In addition, any or all of the following defects shall be sufficient cause for rejection.

- a) Defects that indicate imperfect molding
- b) Defects indicating honeycombed or open texture concrete
- c) Cracked or severely chipped panels
- d) Color variation on from face of panel due to excess form oil or other reasons

809.02.2.2--Modular Block.

809.02.2.2.1--General and Architectural Requirements for Modular Block Units. Unless otherwise specified in the project plans, general and architectural requirements of modular block units shall be as follows:

Face Color – Gray

Face Finish – sculptured rock face in angular multiplaner configuration

Bond Configuration – running with bonds nominally located at the midpoint of vertically adjacent units, in both straight and curved alignments

Exposed surfaces of units shall be free of chips, cracks or other imperfections when viewed from a distance of 10 feet under diffused lighting.

Modular block units shall be manufactured in accordance with ASTM Designations: C 90 and C 140.

809.02.2.2.2--Material Requirements for Modular Block Units. Material requirements shall be as follows:

- 1. Cement: Materials shall conform to the following applicable specifications and requirements:
 - a. Portland Cement: AASHTO Designation: M 85
 - b. Modified Portland Cement: Portland cement conforming to AASHTO Designation: M 85, modified as follows.

Limestone: calcium carbonate, with a minimum 85% content, may be added to the cement, provided these requirements of AASHTO Designation: M 85 as modified are met:

- i) Limitation on insoluble residue, percent 1.5
- ii) Limitation on air content of mortar,
maximum volume percent 22
- iii) Limitations of loss of ignition, percent 7

- c. Blended Cements: AASHTO Designation: M 295
 - d. Pozzolans: AASHTO Designation: M 295
 - e. Blast Furnace Slag Cement: AASHTO Designation: M 302
- 2. Aggregates: Aggregates shall conform to the following specifications, as applicable.
 - a. Normal Mass Aggregates: ASTM Designation: C 33
 - b. Lightweight Aggregates: ASTM Designation: C 331
- 3. Other Constituents: Air entraining agents, coloring pigments, integral water repellents, finely ground silica, and other constituents shall be previously established as suitable for use in modular block retaining wall units and shall conform to applicable AASHTO or ASTM standards or, shall be shown by test or experience to be not detrimental to the durability of the modular block units or any material customarily used in retaining wall construction.

809.02.2.2.3--Structural Requirements for Modular Block Units. Structural requirements for modular block units shall be as follows:

- 1. 28-day Compressive Strength:..... 4,000 psi, minimum
- 2. Absorption: 6% maximum by weight
- 3. Maximum horizontal gap between erected units: 0.5 inch

809.02.2.2.4--Base Leveling Pad Material. Base leveling pad material shall be constructed using non-reinforced concrete and be a minimum of six inches thick by 12 inches wide. Class C concrete shall be used for the base leveling pad material unless otherwise noted in the plans.

809.02.2.2.5--Unit Infill or Drainage Fill. Unit Infill or Drainage Fill shall consist of clean, free draining crushed stone or gravel with a one inch maximum particle size and shall meet the gradation listed below.

<u>Sieve Size</u>	<u>Percent Passing</u>
1"	100
3/4"	75 – 100
# 4	0 – 10
# 40	0 – 5

The Engineer shall approve the gradation of the Unit Infill or Drainage Fill. Pea gravel shall not be used. A minimum of 1.5 cubic foot of drainage fill shall be used for each square foot of wall face. Drainage fill may be placed between, behind, and within the cores of units to meet this requirement. In no case will a geotextile or geocomposite be used as a substitute for the drainage fill.

809.02.2.3--Reinforced Backfill for Mechanically Stabilized Earth Walls. Reinforced backfill shall be free of debris and meet the following gradation requirements:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/4"	75 – 100
# 4	20 – 100
# 40	0 – 60
# 200	0 – 15

The maximum aggregate size shall be limited to 3/4-inch unless field tests have been performed to evaluate potential strength reductions to the geogrid design due to damage during construction.

The plasticity index (P.I.) as determined by AASHTO Designation: T 90 shall not exceed 6.

The backfill material, when compacted to 95% of Standard Proctor, AASHTO Designation: T 99, at optimum moisture content, shall exhibit an angle of internal friction of not less than 34° as determined by a standard direct shear test, AASHTO Designation: T 236, or triaxial test, AASHTO Designation: T 296. In addition, the in-place density shall be within 5% of the assumed density used in wall design calculations.

When metallic reinforcing strips are used, all backfill material shall conform to the following electrochemical requirements:

Electrochemical Properties	Requirements	Test Method, AASHTO Designation
pH	5 – 10	T-289
Resistivity	>3,000 ohms/cm minimum	T-288
Chlorides	<100 ppm maximum	T-291
Sulfates	<200 ppm maximum	T-290
Organic Content	<1%	T-267

Contractor shall submit reinforced backfill sample and laboratory test results to the Engineer for approval prior to the use of any of the proposed reinforced backfill material.

809.02.2.3.1--Metallic Reinforcing and Attachment Devices. All reinforcing and attachment devices shall be inspected to insure they are true to size and free from defects that may impair their strength and durability, and shall meet the following conditions.

1. Reinforcing Strips – Reinforcing strips shall be hot rolled from bars to the required shape and dimensions. Their physical and mechanical properties shall conform to ASTM Designation: A 36 or A 572, Grade 65 or equal. Galvanization shall conform to the minimum requirements set forth in AASHTO Designation: M 111.
2. Reinforcing Mesh – Reinforcing mesh shall be shop fabricated of cold drawn steel wire conforming to the minimum requirements of AASHTO Designation: M 32M/M and shall be welded into the finish mesh fabric in accordance with AASHTO Designation: M 55M/M. Galvanization shall be applied after the mesh is fabricated and conform to the minimum requirements of AASHTO Designation: M 111.
3. Tie Strips – The tie strips shall be shop fabricated of a hot rolled steel conforming to the minimum requirements of ASTM Designation: A 572, Grade 50 or equivalent. Galvanization shall conform to AASHTO Designation: M 111.
4. Fasteners – Fasteners shall consist of 1/2-inch diameter, hexagonal cap screw bolts and nuts, which are galvanized and conform to the requirements of AASHTO Designation: M 164 or equivalent.
5. Connector Pins – Connector pins and mat bars for the MSEW system shall be fabricated from A36 steel and welded to the soil reinforcement mats as shown on the plans. Galvanization shall conform to AASHTO Designation: M 111.

809.02.2.4--Geogrid Reinforcement for Mechanically Stabilized Earth Walls.

809.02.2.4.1--General. A geogrid is defined as a geosynthetic formed by a regular network of integrally connected elements with apertures greater than 0.25 inch to allow interlocking with surrounding soil, rock, earth and other surrounding materials to function primarily as reinforcement.

The geogrid(s) to be utilized in the Modular Block Retaining Wall System shall be creep tested in accordance with ASTM Designation: D 5262. The long term design strength (T_{CR} – Creep Limited Strength) shall be obtained from tests run on representative samples for no less than 10,000 hours. The long term design strength shall be defined as the load at which no more than 10% strain occurs over a 100-year design life.

The geogrid shall be mildew resistant and inert to biological degradation and naturally encountered chemicals, alkalis and acids. The geogrid shall contain stabilizers and/or inhibitors, or a resistance finish or covering to make it resistant to deterioration from direct sunlight, ultraviolet rays, and heat.

809.02.2.4.2--Marking, Shipment and Storage. Each roll or container of geogrid shall be visibly labeled with the name of the manufacturer, trade name of the product, lot number, and quantity of material. In addition, each roll or container shall be clearly tagged to show the type designation that corresponds to that required by the plans. During shipment and storage the geogrid shall be protected from direct sunlight, and temperatures above 120°F or below 0°F. The geogrid shall either be wrapped and maintained in a heavy duty protective covering or stored in a safe enclosed area to protect from damage during prolonged storage.

809.02.2.4.3--Manufacturer's Certification. The Contractor shall furnish the Engineer three copies of the manufacturer's certified test reports indicating that the geogrid furnished conforms to the requirements of the specifications and is of the same composition as that originally approved by the Department.

809.02.2.4.4--Acceptance Sampling and Testing. Final acceptance of each shipment will be based upon results of tests performed by the Department on verification samples submitted from the project, as compared to the manufacturer's certified test reports. The Engineer will select one roll or container at random from each shipment for sampling. A sample extending full width of the randomly selected roll or container and being at least five (5) square yards in area will be obtained and submitted by the Engineer. The sample from each shipment shall be provided at no cost to the State.

809.02.3--Precast Gravity Walls. Materials for precast gravity walls shall meet the following minimum requirements.

809.02.3.1--Foundation Preparation and Base Leveling Pad. The foundation bed for the structure shall be graded as required before erection is started. Prior

to wall construction the foundation shall be compacted as specified in Section 203 of the Standard Specifications.

The base leveling pad may be either precast or cast-in-place, as directed by the wall supplier. The base leveling pad shall be constructed of Class “C” concrete unless otherwise specified and shall be cured until a compressive strength of 2,000 psi is attained before placement of wall modules. The completed surface shall be constructed in accordance with the lines and grades shown on the final wall plans. The base leveling pad shall be plane to within 1/8 inch in 10 feet.

809.02.3.2--Prefabricated Modular Units. Prefabricated modular units shall be designed for developed earth pressures behind the wall and from pressures developed inside the modules. Prefabricated modular units shall be constructed in accordance with *AASHTO Standard Specifications for Highway Bridges, Section 5*.

Concrete for prefabricated modular units shall have a minimum 28-day compressive strength of 5,000 psi. The prefabricated modular units shall not be shipped before attaining the required 5,000 psi compressive strength. Unless otherwise indicated on the plans, the concrete surface for the front face shall have a Class “1” finish as defined in Subsection 804 of the Specifications.

The manufacturing process shall be such that it produces uniform modular units and shall be subject to inspection by the Engineer prior to shipment. Precast units will be subject to rejection if they fail to conform to any of the specification requirements or fail to meet the following tolerances.

- 1. Dimensions not conforming to the following tolerances:

Face of Panes, length or width ±3/16 inch
Deviation From Square, diagonals across front face 5/16 inch
- 2. Honeycombed or open texture
- 3. Any damage which would prevent making a satisfactory joint.
- 4. The date of manufacture, lot number, and type of unit in accordance with the approved erection drawings shall be clearly marked on the inside face of each unit.

809.02.3.3--Backfill Material for Modular Units. Backfill material and the embankment behind the wall shall be placed and compacted in accordance with Section 203 of the Standard Specifications. In the event the select backfill recommended by the wall supplier consists of open-graded rock with insufficient fines for conventional compaction controls, the material shall be compacted to a maximum practical density as determined by the Engineer. Otherwise, the select

backfill material shall be placed and compacted to at least 95% density as determined by AASHTO Designation: T 99.

When the modular backfill material consists of open-graded rock containing insufficient fines to fill the voids between particles in a compacted state, any exposed modular backfill material shall be covered by a layer of Type V nonwoven geotextile to prevent migration of fines into the modular backfill material. The geotextile shall overlap the module a minimum of six inches, except for the front cell.

809.03--Construction Requirements.

809.03.1--General Construction Requirements for All Wall Types.

809.03.1.1--Excavation. The Contractor shall excavate to the lines and grades shown on the final wall plans. The Contractor shall be careful not to disturb the embankment and foundation materials beyond the lines shown. The Engineer will inspect the excavation and give approval prior to placement of the base leveling pad. Soils that the Engineer deems to be unstable or unsuitable shall be excavated and replaced with select borrow material.

Excavation for the wall system shall be as directed by the plans or as directed by the Engineer. Where excavation is required in the immediate vicinity of adjacent structures and/or properties, extreme caution should be exercised. It shall be the Contractor's responsibility to place what bracing, shoring, or ground support system deemed necessary to prevent a failure and protect the persons working near the excavation. The soil supporting the wall system shall be inspected and approved by the Engineer to confirm that the actual foundation soil conditions meet or exceed the assumed design conditions. Over-excavated areas shall be backfilled with select borrow material.

809.03.1.2--Backfill Material. All backfill material shall be compacted in accordance with Section 203 of the Standard Specifications unless otherwise noted on the wall plans. Unless otherwise noted all backfill material shall be placed in non-compacted lifts not to exceed eight inches and be compacted to at least 95% density as determined by AASHTO Designation: T 99. Compaction of the backfill within three feet of the back face of the wall shall be accomplished by making at least three passes with a lightweight mechanical tamper, roller, or vibratory system.

At the end of each day's operation, the Contractor shall slope the last level of backfill away from the wall facing to rapidly direct runoff away from the wall face. In addition, the Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

809.03.2--Conventional Cantilevered Gravity Wall. The Contractor shall be responsible for all temporary shoring required to construct the conventional cantilevered gravity wall in accordance with the wall design.

809.03.3--Mechanically Stabilized Earth Walls. All components of the MSEW wall system shall be installed in strict accordance with the plans and the manufacturer's recommendations. A representative of the wall manufacturer shall be present at the start of construction of the wall to train the Contractor in the proper installation procedures for the chosen wall system.

809.03.3.1--Foundation Preparation. The foundation for the structure shall be graded level for a width equal to the length of the reinforcement elements plus one foot or as directed by the wall plans. Prior to wall construction, the foundation shall be compacted with a smooth wheel vibratory roller. Any foundation soils found to be unsuitable shall be removed and replaced as outlined in Subsection 809.03.1.1.

809.03.3.2--Wall Erection.

809.03.3.2.1--Precast Concrete Facings. Precast concrete panels shall be placed so that their final position is vertical or battered as shown on the wall plans. For erection, panels shall be handled by means of lifting devices connected to the upper edge of the panel. Panels should be placed in successive horizontal lifts in the sequence shown on the wall plans as backfill placement proceeds. As backfill material is placed behind the panels, the panels shall be maintained in position by means of temporary wedges or bracing according to the wall supplier's recommendations. Concrete facing vertical tolerances and horizontal alignment tolerances shall not exceed 3/4 inch when measured with a 10-foot straightedge. During construction, the maximum allowable offset in any panel joint shall be 3/4 inch. The overall vertical tolerance of the wall from top to bottom shall not exceed 1/2 inch per 10 feet of wall height. Reinforcement elements shall be placed normal to the face of the wall, unless otherwise shown on the plans.

809.03.3.2.2--Modular Block Facings. The first course of modular block units shall be carefully placed on the base leveling pad and each unit checked for level and alignment.

Then, the following sequence of operations shall be followed.

1. The modular block units shall be placed so that they are in full contact at the base and properly seated. The modular block units are to be placed side by side for full length of wall alignment. Alignment may be done by means of a string line or offset from a base line.

2. The voids in and around the modular block units shall be filled with unit drainage fill material. Tamp or rod unit drainage fill to insure that all voids are completely filled.
3. The maximum stacked vertical height of wall units, prior to wall drain fill and backfill placement, shall not exceed two courses.
4. Excess material shall be swept from the top of the modular blocks prior to installation of the next course. Ensure that each course of modular block units is completely filled with unit drainage fill before proceeding to next course.
5. Position vertically adjacent units as recommended by the wall manufacturer.
6. Whole or cut units on curves and corners shall be erected with running bond approximately centered on units above and below.
7. Reinforcing shall be laid at the proper elevations and oriented such that the strong direction is normal to the wall alignment. Correct orientation of the reinforcing shall be verified by the Engineer.
8. Splicing of geogrid pieces shall not be allowed unless approved by the Engineer.

809.03.3.2.3--Precast Gravity Walls. At each foundation level, the base leveling pad shall be given a wood float finish and shall be cured a minimum of 72 hours or reach a compressive strength of 2,000 psi before placement of any modular units. The completed surface of the base leveling pad shall not vary more than 1/8 inch in 10 feet.

All precast modular units above the first course shall interlock with lower courses. Vertical joints shall be staggered with each successive course. The vertical joint opening on the front face of the wall shall not exceed 3/4 inch. Joint filler and neoprene pads shall be installed in the horizontal joints of both faces.

All vertical joints between modules shall be covered on the back side of the front face of the wall by a Type V nonwoven geotextile that is a minimum of 18 inches wide. Joints at the corners or angle points shall be closed in accordance with the recommendations of the wall manufacturer.

When the modular backfill material is a rock backfill containing insufficient fines to fill the voids between particles in a compacted state, any exposed modular backfill material shall be covered by a layer of Type V nonwoven geotextile to prevent migration of soil fines into the modular backfill material.

The overall vertical tolerance of the wall, plumbness from top to bottom, shall not exceed 1/2 inch per 10 feet of wall height.

809.04--Method of Measurement. The retaining wall system will be measured by the square foot of accepted vertical face area of the completed structure, constructed as directed by these specifications. The area measured for payment will be computed from the horizontal length of the wall segments and the average wall height between the bottom of the wall or top of the base leveling pad and the top of the wall. In the case of a battered wall, either specified in the plans or battered at the Contractor's option, the vertical distance will be used in the area calculation and not the slope distance along the face of the wall.

809.05--Basis of Payment. The retaining wall system shall be paid for at the contract unit price per square foot, which price shall be full compensation for the design and construction of the retaining wall system, all excavation, select backfill material, leveling pads, undercut, all the materials for the wall drainage system, facing materials, soil reinforcement, equipment, labor, and incidentals necessary to complete the work as directed by the Engineer.

Payment will be made under:

809-A: Retaining Wall System

- per square foot

SECTION 810 - STEEL STRUCTURES

810.01--Description. This work consists of furnishing, fabricating, preparing, assembling, erecting, and painting structural steel and all accessories and other metal parts required in steel spans. This work shall be constructed as indicated on the plans, in reasonably close conformity with the lines, grades, dimensions, and design shown, and in accordance with the applicable provisions and requirements in other sections of these specifications for the different items which constitute the complete structure.

These specifications apply to bolted and welded construction when indicated in the contract.

810.02--Materials.

810.02.1--General. Unless otherwise specified, structural steel, miscellaneous metals, and paints shall conform to the applicable requirements of this section and Sections 710, 716, 717, and 814. Unless otherwise specified, structural carbon steel, ASTM Designation: A 36, shall be furnished.

810.02.2--Drawings. The Contractor shall prepare shop drawings for all materials to be fabricated. The size of the sheets on which the drawings are

prepared shall conform to the standard bridge sheet of the Department. Two complete sets of prints shall be submitted to the Bridge Engineer for approval prior to ordering any materials for fabrication.

For all fabrication to be done by welding, two copies of welding procedures in accordance with the provisions of ANSI/ASSHTO/AWS D1.5 Bridge Welding Code, hereinafter referred to as the Welding Code, shall also be submitted to the Bridge Engineer for approval. After final approval of the shop drawings and welding procedures, if applicable, six complete sets of prints shall be submitted to the Bridge Engineer. As required by special conditions, the Bridge Engineer shall be furnished with as many additional sets of prints as may be necessary. Shop drawings for railroad bridges shall be prepared with ink on linen tracing cloth or other approved equal, which shall be delivered to the Bridge Engineer prior to final acceptance of the project. No changes shall be made in a shop drawing after it has been approved, nor shall steel sections different from those shown on the plans be substituted except with the written consent or direction of the Engineer.

Prior to the fabrication of any part of a structure, shop drawings and welding procedures for that part of the structure shall have been given final, unconditional, approval by the Bridge Engineer. Work performed prior to approval of drawing and procedures may be rejected.

810.02.3--Shop Painting. Shop painting, unless otherwise designated or permitted, shall consist of inorganic zinc primer, Section 710, applied as specified in Section 814. Machine-finished surfaces of pins, pin rollers and bores shall be coated as soon as practicable after acceptance with a heavy coat of Petrolatum meeting the requirements of ASTM Designation: D 217, NLGI Consistency Grade 2 or 3, or other approved coating prior to removal from the shop.

810.02.4--Storage of Materials. Structural material, either plain or fabricated, shall be stored at the bridge shop above ground on platforms, skids, or other supports. It shall be kept free from dirt, grease, and other foreign matter and shall be protected as far as practicable from corrosion.

810.02.5--Straightening Material. Rolled material, before being laid off or worked, must be straight. If straightening is necessary, it shall be done by methods that will not injure the metal. Heat straightening of ASTM Designation: A514/A517 steel shall be done only under rigidly controlled procedures and each application subject to the approval of the Engineer. In no case shall the maximum temperature of the steel exceed 1125°F. Sharp kinks and bends will be cause for rejection of the material.

810.02.6--Curving Rolled Beams and Welded Girders. Steels that are manufactured to a yield point greater than 50,000 psi shall not be heat curved.

810.02.6.1--Type of Heating. Beams and girders may be curved by either continuous or V-type heating as approved by the Engineer. For the continuous method, a strip along the edge of the top and bottom flange shall be heated simultaneously; the strip shall be of sufficient width and temperature to obtain the required curvature. For the V-type heating, the top and bottom flanges shall be heated in truncated triangular or wedge-shaped areas having their bases along the flange edge and spaced at regular intervals along each flange; the spacing and temperature shall be as required to obtain the required curvature, and heating shall progress along the top and bottom flange at approximately the same rate.

For the V-type heating, the apex of the truncated triangular area applied to the inside flange surface shall terminate just before the juncture of the web and the flange is reached. To avoid unnecessary web distortion, special care shall be taken

when heating the inside flange surface so the heat is not applied directly to the web. When the radius of curvature is 1000 feet or more, the apex of the truncated triangular heating pattern applied to the outside flange surface shall extend to the juncture of the flange and web. When the radius of curvature is less than 1000 feet, the apex of the truncated triangular heating pattern applied to the outside flange surface shall extend past the web for a distance equal to $1/8$ of the flange or 3 inches, whichever is less. The truncated triangular pattern shall have an included angle of approximately 15 to 30 degrees, but the base of the triangle shall not exceed 10 inches. Variations in the patterns prescribed above may be made with the approval of the Engineer.

For both types of heating, the flange edges to be heated are those that will be on the inside of the horizontal curve after cooling. Heating both inside and outside flange surfaces is only mandatory when the flange thickness is $1\frac{1}{4}$ inches or greater; in which case, the two surfaces shall be heated concurrently. The maximum temperatures shall be as prescribed below.

810.02.6.2--Temperature. The heat-curving operation shall be conducted in such a manner that the temperature of the steel does not exceed 1150°F as measured by temperature indicating crayons or other suitable means. The girder shall not be artificially cooled until after naturally cooling to 600°F. The method of artificial cooling is subject to the approval of the Engineer.

810.02.6.3--Position for Heating. The girder may be heat- curved with the web in either a vertical or a horizontal position. When curved in the vertical position, the girder shall be braced or supported in such a manner that the tendency of the girder to deflect laterally during the heat- curving process will not cause the girder to overturn.

When curved in the horizontal position, the girder must be supported near its ends and at intermediate points, if required, to obtain a uniform curvature; the

bending stress in the flanges due to the dead weight of the girder must not exceed the usual allowable design stress. When the girder is positioned horizontally for heating, intermediate safety catch blocks must be maintained at the midlength of the girder within two inches of the flanges at all times during the heating process to guard against a sudden sag due to plastic flange buckling.

810.02.6.4--Sequence of Operations. The girder shall be heat curved in the fabrication shop before it is painted. The heat curving operation may be conducted either before or after all the required welding of transverse intermediate stiffeners is completed. However, unless provisions are made for girder shrinkage, connection plates and bearing stiffeners shall be located and attached after heat curving. If longitudinal stiffeners are required, they shall be heat curved or oxygen cut separately and then welded to the curved girder. When cover plates are to be attached to rolled beams, they may be attached before heat curving if the total thickness of one flange and cover plate is less than 2½ inches and the radius of curvature is greater than 1000 feet. For other rolled beams with cover plates, the beams must be heat-curved before the cover plates are attached; cover plates must be either heat curved or oxygen cut separately and then welded to the curved beam.

810.02.6.5--Camber. Girders shall be cambered before heat curving. Camber for rolled beams may be obtained by heat-cambering methods approved by the Engineer. For plate girders, the web shall be cut to the prescribed camber with suitable allowance for shrinkage due to cutting, welding, and heat curving. The heat-curving process may tend to change the vertical camber present before heating. This effect will be most pronounced when the top and bottom flanges are of unequal widths on a given transverse cross section. However, subject to the approval of the Engineer, moderate deviations from specified camber may be corrected by a carefully supervised application of heat.

810.02.6.6--Measurement of Curvature and Camber. Horizontal curvature and vertical camber shall not be measured for final acceptance before all welding and heating operations are completed, and the flanges have cooled to a uniform temperature. Horizontal curvature shall be checked with the girder in the vertical position by measuring off-sets from a string line or wire attached to both flanges or by using other suitable means. Camber shall be checked by adequate means.

810.02.7--Finish. Portions of work exposed to view shall be finished neatly. Shearing, flame cutting, and chipping shall be done carefully and accurately.

810.02.8--Bolt Holes. All holes for bolts shall be either punched or drilled. Material forming parts of a member composed of not more than five thicknesses of metal may be punched 1/16 inch larger than the nominal diameter of the bolts whenever the thickness of the material is not greater than 3/4 inch for structural steel, 5/8 inch for high strength steel, or 1/2 inch for quenched and tempered

alloy steel, unless subpunching and reaming is required under Subsection 810.02.11.1.

When there are more than five thicknesses or when any of the main material is thicker than 3/4 inch for structural steel, 5/8 inch for high strength steel, or 1/2 inch for quenched and tempered alloy steel, all holes shall either be subdrilled or drilled full size.

When required under Subsection 810.02.11, all holes shall be either subpunched or subdrilled 3/16 inch smaller and after assembling, reamed 1/16 inch larger or drilled full size to 1/16 inch larger than the nominal diameter of bolts. Hole shall be subdrilled if thickness limitation governs.

810.02.9--Punched Holes. The diameter of the die shall not exceed the diameter of the punch by more than 1/16 inch. If any holes must be enlarged to admit the bolts, such holes shall be reamed. Holes must be clean cut without torn or ragged edges. Poor matching of holes will be cause for rejection.

810.02.10--Reamed or Drilled Holes. Reamed or drilled holes shall be cylindrical, perpendicular to the member, and shall comply with the requirements of Subsection 810.02.8 as to size. Where practicable, reamers shall be directed by mechanical means. Burrs on the outside surfaces shall be removed. Poor matching of holes will be cause for rejection. Reaming and drilling shall be done with twist drills. If required by the Engineer, assembled parts shall be taken apart for removal of burrs caused by drilling. Connecting parts requiring reamed or drilled holes shall be assembled and securely held while being reamed or drilled and shall be match marked before disassembling.

810.02.11--Preparation of Field Connections.

810.02.11.1--Subpunching and Reaming of Field Connections. Unless otherwise specified, holes in all field connections and field splices of main members of trusses, arches, continuous beam spans, bents, each face of towers, plate girders, and rigid frames shall be subpunched or subdrilled if subdrilling is required by Subsection 810.02.8, and subsequently reamed while assembled or to a steel template, as required by Subsection 810.02.16.

All holes for floorbeam and stringer field end connections shall be subpunched and reamed to a steel template or reamed while assembled.

Reaming or drilling full size of field connection holes through a steel template shall be done after the template has been located with utmost care as to position and angle and firmly bolted in place. Templates used for reaming matching members, or the opposite faces of a single member, shall be exact duplicates. Templates used for connections on like parts or members shall be accurately

located so that the parts or members are duplicates and require no match-marking.

For any connection, in lieu of subpunching and reaming or subdrilling and reaming, the fabricator shall have the option of drilling holes full size with all thicknesses of material assembled in proper position.

If additional subpunching and reaming is required, it shall be as specified on the plans.

810.02.11.2--Numerically-Controlled Drilled Field Connections. Alternately, for any connection or splice designated in Subsection 810.02.11.1 in lieu of sub-sized holes and reaming while assembled, or drilling holes full-size while assembled, the Contractor shall have the option to drill bolt holes full-size in unassembled pieces and/or connections including templates for use with matching sub-sized and reamed holes by means of suitable numerically-controlled (N/C) drilling equipment subject to the specific provisions contained in this article.

If N/C drilling equipment is used, the Engineer, unless otherwise stated in the special provisions or on the plans, may require the Contractor, by means of check assemblies, to demonstrate that this drilling procedure consistently produces holes and connections meeting the requirements of Subsections 810.02.13 and 810.02.16.

The Contractor shall submit to the Engineer for approval a detailed outline of the procedures proposed to be followed in accomplishing the work from initial drilling through check assembly, if required, to include the specific members of the structure that may be N/C drilled, the sizes of the holes, the location of common index and other reference points, composition of check assemblies, and all other pertinent information.

Holes drilled by N/C drilling equipment shall be drilled to appropriate size either through individual pieces or any combination of pieces held tightly together.

810.02.12--Accuracy of Punched and Drilled Holes. All holes punched full size, subpunched, or subdrilled shall be so accurately punched that after assembling, before any reaming is done, a cylindrical pin $\frac{1}{8}$ -inch smaller in diameter than the nominal size of the punched hole may be entered perpendicular to the face of the member, without drifting, in at least 75 percent of the contiguous holes in the same plane. If this requirement is not fulfilled, the badly punched pieces will be rejected. If any hole will not pass a pin $\frac{3}{16}$ inch smaller in diameter than the nominal size of the punched hole, this will be cause for rejection.

810.02.13--Accuracy of Reamed and Drilled Holes. When holes are reamed or drilled, 85 percent of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than 1/32 inch between adjacent thicknesses of metal.

All steel templates shall have hardened steel bushings in holes accurately dimensioned from the center lines of the connection as inscribed on the template. The center lines shall be used in accurately locating the template from the milled or scribed ends of the members.

810.02.14--Fitting for Bolting. Surfaces of metal in contact shall be cleaned before assembling. The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before reaming is commenced. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the reaming operation. The member shall be free from twists, bends, and other deformation.

Preparatory to the shop riveting of full-sized punched material, the rivet holes, if necessary, shall be spear-reamed for the admission of the rivets. The reamed holes shall not be more than 1/16 inch larger than the nominal diameter of the rivets.

End connection angles, stiffener angles, and similar parts shall be carefully adjusted to correct position and bolted, clamped, or otherwise firmly held in place until riveted.

Parts not completely riveted in the shop shall be secured by bolts, insofar as practicable, to prevent damage in shipment and handling.

810.02.15--Blank.

810.02.16--Shop Assembling.

810.02.16.1--General. The field connections of main members of trusses, arches, continuous beam spans, bents, each face of towers, plate girders, and rigid frames shall be assembled in the shop with milled ends of compression members in full bearing, and then shall have their subsize holes reamed to specified size while the connections are assembled. Assembly shall be Full Truss or Girder Assembly unless Progressive Truss or Girder Assembly, Full Chord Assembly, Progressive Chord Assembly, or Special Complete Structure Assembly is specified in the special provisions or on the plans. Modifications to these assemblies may be allowed when approved in writing by the Bridge Engineer.

When required on the plans, check assemblies and N/C drilled field connections shall be in accordance with the provisions of Subsection 810.02.16.7.

Each assembly, including camber, alignment, accuracy of holes, and fit of milled joints, shall be approved by the Engineer before reaming is commenced or before an N/C drilled check assembly is dismantled.

A camber diagram shall be furnished the Engineer by the Fabricator showing the camber at each panel point in the cases of trusses or arch ribs, and at the location of field splices and fractions of span length in case of continuous beam and girders or rigid frames. Fraction points of span lengths shall be 1/4 points minimum, 1/10 points maximum. When the shop assembly is full truss or girder assembly or special complete structure assembly, the camber diagram shall show the camber measured in assembly. When any of the other methods of shop assembly is used, the camber diagram shall show calculated camber.

810.02.16.2--Full Truss or Girder Assembly. Full truss or girder assembly shall consist of assembling all members of each truss, arch rib, bent, tower face, continuous beam line, plate girder, or rigid frame at one time.

810.02.16.3--Progressive Truss or Girder Assembly. Progressive truss or girder assembly shall consist of assembling initially for each truss, arch rib, bent, tower face, continuous beam line, plate girder, or rigid frame at least three contiguous shop sections or all members in at least three contiguous panels but not less than the number of panels associated with three contiguous chord lengths, i.e. length between field splices, and not less than 150 feet in the case of structures longer than 150 feet. At least one shop section or panel or as many panels as are associated with a chord length shall be added at the advancing end of the assembly before any member is removed from the rearward end, so that the assembled portion of the structure is never less than that specified above.

810.02.16.4--Full Chord Assembly. Full chord assembly shall consist of assembling, with geometric angles at the joints, the full length of each chord of each truss or open spandrel arch, or each leg of each bent or tower, then reaming their field connection holes while the members are assembled and reaming the web member connection to steel templates set at geometric not cambered angular relation to the chord lines.

Field connection holes in web members shall be reamed to steel templates. At least one end of each web member shall be milled or shall be scribed normal to the longitudinal axis of the member and the templates at both ends of the member shall be accurately located from one of the milled ends or scribed lines.

810.02.16.5--Progressive Chord Assembly. Progressive chord assembly shall consist of assembling contiguous chord members in the manner specified for full chord assembly and in the number and length specified for progressive truss or girder assembly.

810.02.16.6--Special Complete Structure Assembly. Special complete structure assembly shall consist of assembling the entire structure, including the floor system. This procedure is ordinarily needed only for complicated structures such as those having curved girders, or extreme skew in combination with severe grade or camber, and will be required only when so indicated on the plans.

810.02.16.7--Check Assemblies with Numerically Controlled Drilled Field Connections. Unless otherwise indicated, a check assembly shall be fabricated for each major structural type and shall consist of at least three contiguous shop sections or, in a truss, all members in at least three contiguous panels but not less than the number of panels associated with three contiguous chord lengths; i.e., length between field splices. Check assemblies should be based on the proposed order of erection, joints in bearings, special complex points, and similar considerations. Such special points could be the portals of skewed trusses, etc. Use of either geometric angles, giving theoretically zero secondary stresses under dead-load conditions after erection, or cambered angles, giving theoretically zero secondary stresses under no-load conditions, should be designated on the plans or in the special provisions.

The check assemblies shall preferably be the first such section of each major structural type to be fabricated.

No match-marking and no shop assemblies other than the check assemblies will be required.

If the check assembly fails in some specific manner to demonstrate that the required accuracy is being obtained, further check assemblies may be required by the Engineer for which there shall be no additional cost to the State.

810.02.17--Drifting of Holes. The drifting done during assembling shall be only such as to bring the parts into position and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit the rivets, they shall be reamed.

810.02.18--Match-Marking. Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be match-marked, and a diagram showing such marks shall be furnished to the Engineer.

810.02.19--Blank.

810.02.20--Bolts and Bolted Connections. Bolted connections fabricated using high strength bolts shall conform to Subsection 810.02.21.

810.02.20.1--General. Bolts shall be unfinished, turned, or ribbed bolts conforming to the requirements for Grade A Bolts of Specification for Low-Carbon Steel Externally and Internally Threaded Standard Fasteners, ASTM

Designation: A 307. Bolted connections shall be used only as indicated by the plans or special provisions. Bolts shall have single self-locking nuts or double nuts unless otherwise shown on the plans or in the special provisions. Beveled washers shall be used where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis.

810.02.20.2--Unfinished Bolts. Unfinished bolts shall be furnished unless other types are specified.

810.02.20.3--Turned Bolts. The surface of the body of turned bolts shall meet the ANSI roughness rating value of 125. Heads and nuts shall be hexagonal with standard dimensions for bolts of the nominal size specified or the next larger nominal size. Diameter of threads shall be equal to the body of the bolt or the nominal diameter of the bolt specified. Holes for turned bolts shall be carefully reamed with bolts furnished to provide for a light driving fit. Threads shall be entirely outside of the holes. A washer shall be provided under the nut.

810.02.20.4--Ribbed Bolts. The body of ribbed bolts shall be of an approved form with continuous longitudinal ribs. The diameter of the body measured on a circle through the points of the ribs shall be 5/64 inch greater than the nominal diameter specified for the bolts.

Ribbed bolts shall be furnished with round heads conforming to ANSI B 18.5 unless otherwise specified. Nuts shall be hexagonal, either recessed or with a washer of suitable thickness. Ribbed bolts shall make a driving fit with the holes. The hardness of the ribs shall be such that the ribs do not mash down enough to permit the bolts to turn in the holes during tightening. If for any reason the bolt twists before drawing tight, the hole shall be carefully reamed and an oversized bolt used as a replacement.

810.02.21--Connections Using High Strength Bolts. This subsection covers the assembly of structural joints using ASTM Designation: A 325 high strength bolts for structural steel joints or ASTM A 490 quenched and tempered alloy bolts for structural steel joints, or equivalent fasteners, tightened to a high tension. The bolts are used in holes conforming to the requirements of Subsections 810.02.8, 810.02.9 and 810.02.10.

810.02.21.1--Bolts, Nuts, Washers and Direct Tension Indicators (DTI). All bolts, nuts, washers and DTI shall conform to the requirements of Section 717 for such items.

Unless otherwise shown on the plans, all threaded bolts shall be of sufficient length to provide at least full-thread engagement, as defined in Subsection 810.04.4, immediately prior to final tensioning.

All markings on bolts, nuts, washers and direct tension indicators must include the symbol of the manufacturer and not the distributor or any other trading entity. This is spelled out in all ASTM specifications covering these product categories. A325 bolts shall be marked "A325" and A490 bolts marked "A490". Type 1 A325 bolts shall be marked with three radial lines 120° apart. Type 3 A325 bolts shall have A325 underlined plus other distinguishing marks indicating that the bolt is atmospheric corrosion resistant and of a weathering type. Type 2 A325 bolts shall be marked with three radial lines 60° apart. Direct tension indicators shall also be marked "325" in the case of Type "325" or "490".

810.02.21.2--Bolted Parts. The slope of surfaces of bolted parts in contact with the bolt head and nut shall not exceed 1:20 with respect to a plane normal to the bolt axis. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material.

When assembled, all joint surfaces, including those adjacent to the bolt heads, nuts, or washers, shall be free of scale, except tight mill scale, and shall also be free of dirt, loose scale, burrs, other foreign material, and other defects that would prevent solid seating of the parts. Paint is permitted in bearing-type connections.

Contact surfaces within friction-type joints shall be free of oil, paint, lacquer or other coatings, except as listed below:

- A. Hot dip galvanizing, if contact surfaces are scored by wire brushing or blasting after galvanizing and prior to assembly. The wire brushing treatment shall be a light application of manual brushing, not power wire brushing, that marks or scores the surface but removes relatively little of the zinc coating. The blasting treatment shall be a light "brush-off" treatment which will produce a dull gray appearance. However, neither treatment should be severe enough to produce any break or discontinuity in the zinc surface.
- B. Inorganic zinc rich paints as specified in Subsection 710.03.

ASTM A 325 Type 2 and ASTM A 490 bolts shall not be galvanized nor shall they be used to connect galvanized material.

810.03--Construction Requirements.

810.03.1--Installation.

810.03.1.1--Bolt Tension. Each fastener shall be tightened to provide, when all fasteners in the joint are tight, at least the minimum bolt tension for the size and grade of fastener used, as shown in the following table:

BOLT TENSION

Bolt Size, <u>inches</u>	Minimum Bolt Tension, pounds	
	<u>ASTM A 325 Bolts</u>	<u>ASTM A 490 Bolts</u>
1/2	12,050	14,900
5/8	19,200	23,700
3/4	28,400	35,100
7/8	39,250	48,500
1	51,500	63,600
1 1/8	56,450	80,100
1 1/4	71,700	101,800
1 3/8	85,450	121,300
1 1/2	104,000	147,500

The rotational-capacity test described in Subsection 717.02.3.4 shall be performed on each rotational-capacity lot prior to the start of bolt installation. Hardened steel washers are required as part of the test although they may not be required in the actual installation procedure.

A Skidmore-Wilhelm Calibrator or an equivalent tension measuring device shall be required at each job site during erection. Periodic testing, at least one each working day when the calibrated wrench method is used, shall be performed to assure compliance with the installation requirements for calibrated wrench tightening, turn-of nut tightening or direct tension indicators (DTI) tightening.

The Contractor shall provide all wrenches necessary for obtaining the specified bolt tension, and shall also provide, at no additional costs to the State, the necessary inspection wrenches and provisions for calibration of such wrenches as specified in this subsection and in Subsection 810.03.2.

Threaded bolts shall be checked for tension with properly calibrated wrenches, by the turn-of-nut method, or by the use of Direct Tension Indicators. When required because of bolt entering and wrench operating clearances, tightening may be accomplished by turning the bolt while the nut is prevented from rotating, provided the requirements of Subsections 810.03.1.2 and 810.03.1.5 are met.

Impact wrenches, if used, shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately 10 seconds.

ASTM A490 and galvanized ASTM A325 bolts shall not be reused. Other ASTM A325 bolts may be reused, but not more than once, if approved by the Engineer. Retightening previously tightened bolts which may have been loosened by the tightening of adjacent bolts shall not be considered as a reuse.

Galvanized nuts shall be checked to verify that a visible lubricant is on the threads. Black bolts shall "oily" to the touch when delivered and installed. Weathered or rusted bolts and nuts shall be cleaned and relubricated prior to installation. Bolt, nut and washer, when required, combinations as installed shall be from the same rotational-capacity lot, reference Subsection 717.02.

810.03.1.2--Washers. All fasteners shall have a hardened washer under the element (nut or bolt head) turned in tightening except that ASTM A325 bolts installed by the turn of the nut method in holes which are not oversize or slotted may have the washer omitted. Hardened washers shall be used under both the head and nut regardless of the element turned in the case of ASTM A490 bolts if the material against which it bears has a specified yield strength less than 40 ksi. When ASTM A 490 bolts over one inch in diameter are used in conjunction with short slotted or oversized holes, the hardened washers shall be at least 5/16 inch thick.

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, a smooth beveled washer shall be used to compensate for the lack of parallelism.

810.03.1.3--Calibrated Wrench Tightening. When calibrated wrenches are used to provide the bolt tension specified in Subsection 810.03.1.1, their setting shall be such as to induce a bolt tension five percent to ten percent in excess of this value. These wrenches shall be calibrated at least once each working day by tightening, in a device capable of indicating actual bolt tension, not less than three typical bolts of each diameter to be installed. Power wrenches shall be adjusted to stall or cut-out at the selected tension. If manual torque wrenches are used, the torque indication corresponding to the calibrating tension shall be noted and used in the installation of all bolts of the tested lot. Nuts shall be in the tightening direction when torque is measured. When using calibrated wrenches to install several bolts in a single joint, the wrench shall be returned to "touch up" bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the specified tension.

The required torque for calibrated wrenches may be approximated by the following formula:

$$T(\text{inch-pounds}) = 0.2 \times \text{Bolt Diameter (inches)} \times \text{Bolt Tension (pounds)}$$

810.03.1.4--Turn-of-Nut Tightening. When the turn-of-nut method is used to provide the bolt tension specified in Subsection 810.03.1.1, there shall first be enough bolts brought to a "snug tight" condition to insure that the parts of the joint are brought into full contact with each other. "Snug tight" is defined as the initial tightening of the nut such that a load in the bolt of not less than 10% of the specified proof load for each type and size bolt used is produced. Following this initial operation, bolts shall be placed in the remaining holes in the connection

and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable nut rotation specified in the following table with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

NUT ROTATION⁽¹⁾ FROM SNUG-TIGHT CONDITION

For coarse thread heavy hexagon structural bolts of all sizes and lengths and heavy hexagon semi-finished nuts

	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.	Bolt 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	2/3 turn**	5/6 turn**	1 turn**

(1) Nut rotation is rotation relative to bolt regardless of the element, nut or bolt, being turned.

* Rotation Tolerance: Plus or minus 30 degrees

** Rotation Tolerance: Plus or minus 45 degrees

810.03.1.5--Direct Tension Indicators (DTI) Tightening. When DTI are required on the plans, the Contractor shall furnish a copy of the manufacturer's written installation instructions to the Bridge Engineer for approval prior to beginning work.

It shall be the Contractor's responsibility to have a manufacturer's representative on the job site during initial installation of bolted connections to instruct personnel on the correct method of installation and inspection of the DTI. The DTI shall be installed and the bolts tightened in strict accordance with the manufacturer's written instruction. The DTI are in addition to washers required by the plans and Standard Specifications.

DTI protrusions for all installations shall bear against a hardened unturned surface, normally either the underside of the bolt head or a hardened washer, and never directly against the turned element.

Prior to the final tightening of all high strength bolts, all the plies of steel shall be drawn together by partially compressing DTI protrusions to ensure "snug tight" conditions. The final tightening shall progress systematically from the most rigid part of the joint to its free edges until the DTI on all bolts are closed to 0.005 inch.

DTI shall not be reused. If it becomes necessary to loosen a bolt previously tensioned, the DTI shall be discarded and replaced.

Bolts shall be of sufficient length to accommodate an indicator and washers made necessary by its use.

The Contractor shall furnish a Skidmore-Wilhelm device or approved equal capable of measuring actual bolt tension. At least three typical bolts and direct tension indicators shall be tightened in a device capable of determining their performance characteristics prior to the start of bolt placement. The device shall be made available thereafter during bolt placement for similar checks not to exceed intervals of one week unless directed otherwise by the Bridge Engineer.

High strength bolts, nuts, washers, and direct tension indicators shall be shipped to the project site in sealed metal containers or an approved equal. They shall be stored out of the weather in a location approved by the Engineer. The containers shall remain unopened until the contents are needed for erection. Bolts which, before use, have been exposed and become dried out or rusty will be rejected and will not be used until they are cleaned and lubricated.

810.03.1.6--Lock-Pin and Collar Fasteners. The installation of lock-pin and collar fasteners shall be by methods and procedures approved by the Engineer.

810.03.2--Inspection. The Engineer will observe the installation and tightening of bolts to determine that the selected tightening procedure is properly used and will determine that all bolts are tightened. When the calibrated wrench method of tightening is used, the Engineer will have full opportunity to witness the calibration tests prescribed in Subsection 810.03.1.3.

The following inspection shall be used unless a more extensive or different inspection procedure is specified.

810.03.2.1. Either the Engineer, or the Contractor in the presence of the Engineer, shall use an inspecting wrench which may be either a torque wrench or a power wrench that can be accurately adjusted in accordance with the requirements of Subsection 810.03.1.3.

810.03.2.2. Three bolts of the same grade, size and conditions as those under inspection shall be placed individually in a calibration device capable of indicating bolt tension. The length of the bolt may be any length representative

of bolts used in the structure. There shall be a washer under the part turned in tightening each bolt.

810.03.2.3. When the inspecting wrench is a torque wrench, each bolt specified in Subsection 810.03.2.2 shall be tightened in the calibration device by any convenient means to the minimum tension specified for its size in Subsection 810.03.1.1. The inspecting wrench then shall be applied to the tightened bolt and the torque necessary to turn the nut or head five degrees, approximately one inch at 12-inch radius, in the tightening direction shall be determined. The average torque measured in the tests of three bolts shall be taken as the job inspecting torque to be used in the manner specified in Subsection 810.03.2.5.

810.03.2.4. When the inspecting wrench is a power wrench it shall be adjusted so that it will tighten each bolt specified in Subsection 810.03.2.2 to a tension at least five but not more than ten percent greater than the minimum tension specified for its size in Subsection 810.03.1.1. This setting of wrench shall be taken as the job inspecting torque to be used in the manner specified in the following paragraph.

810.03.2.5. Bolts represented by the sample prescribed in Subsection 810.03.2.2 which have been tightened in the structure shall be inspected by applying, in the tightening direction, the inspecting wrench and its job inspecting torque to ten percent of the bolts, but not less than two bolts, selected at random in each connection. If no nut or bolt head is turned by this application of the job inspecting torque, the connection shall be accepted as properly tightened. If any nut or bolt head is turned by the application of the job inspecting torque, this torque shall be applied to all bolts in the connection, and all bolts whose nut or head is turned by the job inspecting torque shall be tightened and reinspected, or alternatively, the fabricator or erector, at no additional costs to the State, may re-tighten all of the bolts in the connection in the manner required and subject to the limitations imposed for the initial tightening and then resubmit the connection for the specified inspection.

810.03.2.6. When direct tension indicators are used, the Department's inspector will check for correct tensioning by inserting a correct-thickness pointed feeler gage into the opening between adjacent flattened protrusions in accordance with the manufacturer's instructions and Subsection 810.03.1.5. At least ten percent, but no less than two, of the bolts in each connection will be examined.

A nil gap on ASTM A325 bolts is not cause for rejection. A nil gap for ASTM A490 bolts is not allowed.

810.03.2.7. The procedures for inspecting and testing the lock-pin and collar fasteners and their installation to insure that the required pre-load tension is provided shall be as approved by the Engineer.

810.03.3--Blank.

810.03.4--Plate Cut Edges.

810.03.4.1--Edge Planing. Sheared edges of plates more than 5/8 inch in thickness and carrying calculated stress shall be planed to a depth of 1/4 inch. Re-entrant cuts shall be filleted to a minimum radius of 3/4 inch before cutting.

810.03.4.2--Visual Inspection and Repair of Plate Cut Edges. Visual inspection and repair of plate cut edges shall be in accordance with the Welding Code.

810.03.5--Welds. Welding of steel structures, when authorized on the plans or on approved working drawings, and pre-qualification of welding operators shall conform to the Welding Code.

Welding shall be tested by non-destructive methods as prescribed in the Welding Code and as indicated on the plans. Edge blocks shall be used when radiographing butt welds greater than 1/2 inch thickness. The edge blocks shall have a length sufficient to extend beyond each side of the weld centerline for a minimum distance equal to the weld thickness, but no less than two inches, and shall have a thickness equal to or greater than the thickness of the weld. The minimum width of the edge blocks shall be equal to half the weld thickness, but not less than 1 inch. The edge blocks shall be centered on the weld with a snug fit against the plate being radiographed, allowing no more than 1/16 inch gap. Edge blocks shall be made of radiographically clean steel and the surface shall have a finish of ANSI 125 μ inch, or smoother. Non-destructive testing shall be performed at the expense of the Contractor.

810.03.6--Oxygen Cutting. All oxygen cutting shall conform to the Welding Code.

810.03.7--Facing of Bearing Surfaces. The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall meet the ANSI surface roughness requirements as defined in ANSI B 46.1, Surface Roughness, Waviness, and Lay, Part 1:

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

810.03.8--Abutting Joints. Abutting joints in compression members and girder flanges, and in tension members where so specified on the drawings, shall be faced and brought to an even bearing. Where joints are not faced, the opening shall not exceed 1/4 inch.

810.03.9--End Connection Angles. Floorbeams, stringers and girders having end connection angles shall be built to the exact length shown on the plans measured between the heels of the connection angles, with a permissible tolerance of zero inch to minus 1/16 inch. Where continuity is to be required, end connections shall be faced. The thickness of the connection angles shall not be less than 3/8 inch or that shown on the detail drawings.

810.03.10--Lacing Bars. The ends of lacing bars shall be neatly rounded unless another form is required.

810.03.11--Fabrication of Members. Unless otherwise shown on the plans, steel plates for main members and splice plates for flanges and main tension members, not secondary members, shall be cut and fabricated so that the primary direction of rolling is parallel to the direction of the main tensile and/or compressive stresses.

Fabricated members shall be true to line and free from twists, bends and open joints.

810.03.12--Web Plates. In girders having no cover plates and not to be encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than 1/8 inch below at any point. Any portion of the plate projecting beyond the angles shall be chipped flush with the backs of the angles. Web plates of girders having cover plates may be 1/2 inch less in width than the distance back to back of flange angles.

Splices in webs of girders without cover plates shall be sealed on the top with red lead paste prior to painting.

At web splices, the clearance between the end of the web plates shall not exceed 3/8 inch. The clearance at the top and bottom ends of the web splice plates shall not exceed 1/4 inch.

810.03.13--Bent Plates. Unwelded, cold-bent, load-carrying, rolled-steel plates shall conform to the following:

- A. They shall be so taken from the stock plates that the bend line will be at right angles to the direction of rolling, except that cold-bent ribs for orthotropic decks bridges may be bent in the direction of rolling if permitted by the Engineer.

B. Bending shall be such that no cracking of the plate occurs. Minimum bend radii, measured to the concave face of the metal, are shown in the following table:

THICKNESS IN INCHES

	Up to 1/2	Over 1/2 to 1	Over 1 to 1½	Over 1½ to 2½	Over 2½ to 4
All grades of steel	2t	2½t	3t	3½t	4t

Note: Low alloy steel in thicknesses over 1/2 inch may require hot bending for small radii.

Allowance for springback of ASTM A514 and A517 steels should be about three times that for structural carbon steel. For break press forming, the lower die span should be at least 16 times the plate thickness. Multiple hits are advisable.

If a shorter radius is essential, the plates shall be bent hot at a temperature not greater than 1200° F, except for ASTM A514/A517 steel. If ASTM A514/A517 steel plates to be bent are heated to a temperature greater than 1125°F, they must be requenched and tempered in accordance with the producing mill's practice. Hot bent plates shall conform to requirement A.

C. Before bending, the corners of the plate shall be rounded to a radius of 1/16 inch throughout the portion of the plate at which the bending is to occur.

810.03.14--Fit of Stiffeners. End stiffeners of girders and stiffeners intended as supports for concentrated loads shall have full bearing, either milled, ground or on weldable steel in compression areas of flanges, welded as shown on the plans or specified, on the flanges to which they transmit load or from which they receive load. Stiffeners not intended to support concentrated loads shall, unless shown or specified otherwise, fit sufficiently tight to exclude water after being painted. Fillers under stiffeners shall fit within 1/4 inch at each end.

810.03.15--Eyebars. Pin holes may be flame cut at least two inches smaller in diameter than the finished pin diameter. All eyebars that are to be placed side by side in the structure shall be securely fastened together in the order that they will be placed on the pin and bored at both ends while so clamped. Eyebars shall be packed and match marked for shipment and erection. All identifying marks shall be stamped with steel stencils on the edge of one head of each member after fabrication is completed so as to be visible when the bars are nested in place on

the structure. The eyebars shall be straight and free from twists and the pin holes shall be accurately located on the centerline of the bar. The inclination of any bar to the plane of the truss shall not exceed 1/16 inch to a foot.

The edges of eyebars that lie between the transverse centerline of their pin holes shall be cut simultaneously with two mechanically operated torches abreast of each other, guided by a substantial template, in such a manner as to prevent distortion of the plates.

810.03.16--Annealing and Stress Relieving. Structural members which are indicated to be annealed or normalized shall have finished machining, boring, and straightening done subsequent to heat treatment. Normalizing and annealing, full annealing, shall be as specified in ASTM Designation: E 44. The temperatures shall be maintained uniformly throughout the furnace during the heating and cooling so that the temperature at no two points on the member will differ by more than 100°F at any one time.

Members of ASTM A514/A517 steels shall not be annealed or normalized and shall be stress relieved only with the approval of the Engineer.

A record of each furnace charge shall identify the pieces in the charge and show the temperatures and schedule actually used.

Proper instruments, including recording pyrometers, shall be provided for determining at any time the temperatures of members in the furnace. The records of the treatment operation shall be available to and meet the approval of the Engineer. The holding temperature for stress relieving ASTM A514/A517 steel shall not exceed 1125°F.

Members, such as bridge shoes, pedestals, or other parts which are built up by welding sections of plate together shall be stress relieved in accordance with the Welding Code.

810.03.17--Pins and Rollers. Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws. Pins and rollers more than nine inches in diameter shall be forged and annealed. Pins and rollers nine inches or less in diameter may be either forged and annealed or cold-finished carbon-steel shafting.

In pins larger than nine inches in diameter, a hole not less than two inches in diameter shall be bored full length along the axis after the forging has been allowed to cool to a temperature below the critical range under suitable conditions to prevent injury by too rapid cooling and before being annealed.

810.03.18--Boring Pin Holes. Pin holes shall be bored true to the specified diameter, smooth, and straight, at right angles with the axis of the member, and

parallel with each other unless otherwise required. The final surface shall be produced by a finishing cut.

The distance outside to outside of end holes in tension members and inside to inside of end holes in compression members shall not vary from that specified by more than 1/32 inch. Boring of holes in built-up members shall be done after the riveting is complete.

810.03.19--Pin Clearances. The diameter of the pin hole shall not exceed that of the pin by more than 1/50 inch for pins five inches or less in diameter or 1/32 inch for larger pins.

810.03.20--Threads for Bolts and Pins. Threads for all bolts and pins for structural steel construction shall conform to the Unified Standard Series UNC-ANSI B1.1, Class 2A for external threads and Class 2B for internal threads, except that pin ends having a diameter of 1 3/8 inches or more shall be threaded six threads to the inch.

810.03.21--Pilot and Driving Nuts. Two pilot nuts and two driving nuts for each size of pin shall be furnished, unless otherwise specified.

810.03.22--Notice of Beginning Work. The Contractor shall give the Engineer ample notice of the beginning of work at the mill or in the shop so that inspection may be provided. The term "mill" means any rolling mill or foundry where material for the work is to be manufactured. No material shall be manufactured or work done in the shop before the Engineer has been so notified.

Prior to any fabrication, the fabricator shall have on hand Shop Drawings, Weld Procedures and a procedure for storage and handling of welding electrodes, wire and flux which have been approved by the Bridge Engineer. No fabrication shall begin until a prefabrication conference has been held and the facilities have been inspected and approved by the Bridge Engineer.

When ordering structural steel, the fabricator shall specify the current ASTM designation for the material based on the date of advertisement for bids.

810.03.23--Facilities for Inspection. The Contractor shall furnish facilities for the inspection of material and workmanship in the mill and shop, and the inspectors shall be allowed free access to the necessary parts of the works.

Inspection at the mill and shop is intended as a means of facilitating the work and avoiding errors, and it is expressly understood that it will not relieve the Contractor from any responsibility in regard to imperfect material or workmanship and the necessity for replacing same.

810.03.24--Inspector's Authority. Inspectors shall have the authority to reject any material or work which does not meet the requirements of the specifications. In case of dispute, the Contractor may appeal to the Engineer, whose decision shall be final.

The acceptance of any material or finished members by the inspector shall not be a bar to their subsequent rejection, if found defective. Rejected material and workmanship shall be replaced promptly or made good by the Contractor.

Material and workmanship not previously inspected will be inspected after its delivery to the site of the work.

810.03.25--Working Drawings and Identification of Steel During Fabrication.

810.03.25.1--Working Drawings. Shop drawings and other required drawings shall be submitted to the Engineer in accordance with and subject to the provisions of Subsection 810.02.2.

Shop drawings for steel structures shall give full detailed dimensions and sizes of component parts of the structure and details of all miscellaneous parts such as pins, nuts, bolts, rivets, drains, etc.

The Contractor shall expressly understand that the Engineer's approval of the working drawings cover the requirements for "strength and detail," and the Engineer assumes no responsibility for errors in dimensions.

810.03.25.2--Identification of Steels During Fabrication.

810.03.25.2.1--Identification by Contractor. The Engineer shall be furnished with four complete copies of certified mill test reports showing chemical analysis and physical tests for each heat of steel for all members unless excepted by the Engineer. Each piece of steel to be fabricated shall be properly identified for the Engineer.

Shop drawings shall specifically identify each piece that is to be made of steel other than ASTM A36. Pieces made of different grades of steel shall not be given the same assembling or erecting mark, even though they are of identical dimensions and detail.

The Contractor's system of assembly-marking individual pieces, required to be made of steel other than ASTM A36, and the issuance of cutting instructions to the shop, generally by cross-referencing of the assembly-marks shown on the shop drawings with the corresponding item covered on the mill purchase order, shall be such as to maintain identity of the mill test report number.

Material the Contractor can identify by heat number and mill test report may be furnished from stock.

All excess material placed in stock for later use shall be marked with the mill test report number and shall be marked with its ASTM A6 specification identification color code, see table below, when separated from the full-size pieces furnished by the supplier.

810.03.25.2.2--Identification of Steels During Fabrication. During fabrication, up to the point of assembling members, each piece of steel, other than ASTM A36, shall show clearly and legibly its specification identification color code shown in the table below.

Individually marked pieces of steel which are used in furnished size, or reduced from furnished size only by end or edge trim, that does not disturb the heat number or color code or leave any usable piece may be used without further color coding provided that the heat number or color code remains legible.

Pieces of steel, other than ASTM A36, which are to be cut to smaller size pieces shall, before cutting, be legibly marked with the ASTM A6 specification identification color code.

Individual pieces of steel, other than ASTM A36, which are furnished in tagged lifts or bundles shall be marked with the ASTM A6 specification identification color code immediately upon being removed from the bundle or lift.

Pieces of steel, other than ASTM A36, which, prior to assembling into members, will be subject to fabricating operations such as blast cleaning, galvanizing, heating for forming, or painting which might obliterate paint color code marking shall be marked for grade by steel die stamping or by a substantial tag firmly attached.

The following identification color code shall be used to identify material required to meet the individual specifications listed.

IDENTIFICATION COLOR CODES

ASTM A 36	White
ASTM A 514	Red
ASTM A 517	Red and Blue
ASTM A 572, Grade 50	Green and Yellow
ASTM A 588	Blue and Yellow
ASTM A 852	Blue and Orange

Other steels, except ASTM A36, not covered above, nor included in the ASTM A6 Specification, shall have an individual color code which shall be established and on record for the Engineer.

810.03.25.2.3--Certification of Identification. Upon request, the Contractor shall furnish an affidavit certifying that throughout the fabrication operation, the identification of steel has been maintained in accordance with this specification.

810.03.26--Full Size Tests. When full size tests of fabricated structural members or eyebars are required, the plans or specifications will state the number and the nature of the tests, the results to be attained, and the measurements of strength, deformation, or other performance that are to be made. The Contractor shall provide suitable facilities, material, supervision, and labor necessary for making and recording the tests. The members tested in accordance with the contract will be measured for payment in accordance with Subsection 810.04. The cost of testing including equipment, handling, supervision, labor, and incidentals for making the tests shall be included in the contract price for the fabrication or fabrication and erection of structural steel, whichever is the applicable item in the contract, unless otherwise specified.

810.03.27--Marking and Shipping. Each member shall be painted or marked with an erection mark for identification, and an erection diagram shall be furnished with erection marks shown thereon.

The Contractor shall furnish to the Engineer as many copies of material orders, shipping statements, and erection diagrams as the Engineer may direct. The weights of the individual members shall be shown on the statements. Members weighing more than three tons shall have the weights marked thereon. Structural members shall be loaded on trucks or cars in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed, or otherwise damaged.

Bolts of one length and diameter and loose nuts or washers of each size shall be packed separately. Pins, small parts, and packages of bolts, washers, and nuts shall be shipped in boxes, crates, kegs, or barrels, but the gross weight of any package shall not exceed 300 pounds. A list and description of the contained material shall be plainly marked on the outside of each shipping container.

When Direct Tension Indicators are required on plans, the bolts, nuts, washers and DTI shall be shipped and stored in accordance with Subsection 810.03.1.5.

810.03.28--Erection of Structure. If the substructure and superstructure are built under separate contracts, the Department will provide the masonry, constructed to correct lines and elevations and properly finished.

The Contractor shall erect the metal work, remove the temporary construction, and do all work required to complete the bridge or bridges as covered by the contract, including the removal of the old structure if stipulated, all in accordance with the plans and these specifications.

810.03.28.1--Plans. If the fabrication and erection of the superstructure are done under separate contracts, the Department will furnish detail plans for the bridge or bridges to be erected, including shop details, camber diagrams, erection diagrams, list of field rivets and bolts, and copy of shipping statements showing a list of parts and their weights.

810.03.28.2--Plant. The Contractor shall provide the falsework and all tools, machinery, and appliances, including drift pins and fitting-up bolts necessary for the expeditious prosecution of the work.

810.03.28.3--Delivery of Material. If the contract is for erection only, the Contractor shall receive the materials entering into the finished structure, free of charge at the place designated and loaded or unloaded as specified.

810.03.28.4--Handling and Storing Materials. Material to be stored shall be placed on skids above the ground. It shall be kept clean and properly drained. Girders and beams shall be placed upright and shored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent injury from deflection. If the contract is for erection only, the Contractor shall check the material supplied against the shipping lists and report promptly in writing all shortages or injuries discovered. After receiving the material, the Contractor shall be responsible for the loss of any material and for all damage caused to it.

810.03.28.5--Falsework. The falsework shall be properly designed and substantially constructed and maintained for the loads which will come upon it. The Contractor, if required, shall prepare and submit to the Engineer for approval plans for falsework or for changes in an existing structure necessary for maintaining traffic. Approval of the Contractor's plans shall not be considered as relieving the Contractor of any responsibility.

810.03.28.6--Methods and Equipment. Before starting erection, the Contractor shall inform the Engineer fully as to the proposed method of erection and the amount and character of equipment proposed for use, all of which shall be subject to the approval of the Engineer. The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety of the method or equipment used or from carrying out the work in full accordance with the plans and specifications. No work shall be done until the approval of the Engineer has been obtained.

810.03.28.7--Bearings and Anchorages. Masonry bearing plates shall not be placed upon bridge seat bearing areas which are improperly finished, deformed, or irregular. Bearing plates shall be set level in exact position and shall have a full and even bearing upon the masonry. Unless otherwise directed by the Engineer, they shall be placed on a layer of sheet lead one-eighth inch in thickness.

Elastomeric bearing pads, if used, shall be set directly on the masonry.

The Contractor shall drill the holes and set the anchor bolts, except where the bolts are built into the masonry. The bolts shall be set accurately and fixed with portland cement grout completely filling the holes.

Location of anchors and setting of rockers or rollers shall take into account the variation from mean temperature at time of setting and anticipated lengthening of bottom chord or bottom flange due to dead load after setting, the intention being that, as near as practicable, at mean temperature and under dead load the rockers and rollers shall set vertical and anchor bolts at expansion bearings will center their slots. Care shall be taken that full and free movement of the superstructure at the movable bearings is not restricted by improper setting or adjustment of bearings or anchor bolt and nuts.

810.03.28.8--Straightening Bent Material. The straightening of plates, angles, other shapes, and built-up members, when permitted by the Engineer, shall be done by methods that will not produce fracture or other injury. Distorted members shall be straightened by mechanical means or, if approved by the Engineer, by the carefully planned and supervised application of limited localized heat, except that heat straightening of ASTM A514/A517 steel members shall be done only under rigidly controlled procedures, each application subject to the approval of the Engineer. In no case shall the maximum temperature of ASTM A514/A517 steel exceed 1125°F, nor shall the temperature exceed 950°F at the weld metal or within six inches of weld metal. Heat shall not be applied directly on weld metal. In all other steels, the temperature of the heated area shall not exceed 1200°F, a dull red, as controlled by temperature indicating crayons, liquids, or bimetal thermometers.

Parts to be heat straightened shall be substantially free of stress and from external forces, except stresses resulting from mechanical means used in conjunction with the application of heat.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

810.03.28.9--Cambering. Correction of errors in camber in welded beams and girders of ASTM A514/A517 material shall be done only under rigidly controlled procedures, each application subject to approval of the Engineer.

810.03.28.10--Assembling Steel. The parts shall be accurately assembled as shown on the plans and any match-marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken, or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled. Unless erected by the cantilever method, truss spans shall be erected on blocking so as to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are fully bolted and all other truss connections pinned and bolted. Permanent bolts in splices of butt joints of compression members and permanent bolts in railings shall not be driven or tightened until the span has been swung. Splices and field connections shall have one half of the holes filled with bolts and cylindrical erection pins, half bolts and half pins, before bolting with high strength bolts. Splices and connections carrying traffic during erection shall have three-fourths of the holes so filled.

810.03.28.11--Blank.

810.03.28.12--Pin Connections. Pilot and driving nuts shall be used in driving pins. They shall be furnished by the Contractor without charge. Pins shall be so driven that the members will take full bearing on them. Pin nuts shall be screwed up tight and the threads burred at the face of the nut with a pointed tool.

810.03.28.13--Misfits. The correction of minor misfits involving harmless amounts of reaming, cutting and chipping will be considered a legitimate part of the erection. However, any error in the shop fabrication or deformation resulting from handling and transportation which prevents the proper assembling and fitting up of parts by the moderate use of drift pins or by a moderate amount of reaming and slight chipping or cutting shall be reported immediately to the inspector. The method of correction shall require approval by the inspector in whose presence the correction will be made. If the contract provides for complete fabrication and erection, the Contractor shall be responsible for all misfits, errors, and injury and shall make the necessary corrections and replacements. If the contract is for erection only, the inspector, with the cooperation of the Contractor, will keep a correct record of labor and materials used, and the Contractor shall render within 30 days an itemized bill for the approval of the Engineer.

810.03.29--Removal of Old Structures and Falsework. Unless the contract indicates that an old structure is to remain in place, the Contractor shall dismantle and dispose of such structure in accordance with the methods and requirements set out in Section 202.

Upon completion of the erection and before final acceptance, the Contractor shall remove all falsework, excess excavation and useless materials.

All excavated material or falsework placed in the stream channel during construction shall be removed by the Contractor before final acceptance.

810.04--Method of Measurement.

810.04.1--General. The steel superstructure will be measured as a lump sum quantity, complete in place. Structural steel will be measured for payment by the pound based on the weight of metal in the fabricated structure as provided in the contract.

Miscellaneous material items such as castings, bearing plates, lead sheets, anchor bolts, and all other metal for which no direct payment is specified and the contract proposal does not include a bid item for miscellaneous bridge appurtenances will be included in the measurement for structural steel except when the plans and specifications provide that payment will not be allowed for certain materials. When direct tension indicators are not required by the contract and the Contractor elects to use such indicators, no measure for payment will be allowed.

810.04.2--Miscellaneous Bridge Appurtenances. When the bid schedule of the contract contains a pay item for Miscellaneous Bridge Appurtenances, measurement will not be made of individual miscellaneous items, but all will be included in a single lump sum quantity, including all miscellaneous metals and other miscellaneous materials and work not specified to be measured for payment under or to be included in other items of work.

810.04.3--Payment of Weights.

Weights of metals to be paid for shall be based on computed weights.

The weights of erection bolts, extra field rivets or high strength bolts, paint, and all boxes, crates, or other containers used for packing, together with sills, struts, and rods used for supporting members during transportation will be excluded. All metals not to remain in the completed structure will not be computed for payment.

Where increases in size or weights of members have been made which were not ordered by the Engineer, but approved by him, measurement will be made on the sizes or weights indicated on the plans.

Full size members which are tested as required under Subsection 810.03.26 and meet the requirements of these specifications will be measured for payment at the same rate as for the structure.

810.04.4--Computation of Weights.

The weights of metals specified to be paid for by weight will be computed for payment from the following table:

<u>Metal</u>	<u>Weight in Pounds Per Cubic Foot of Material</u>
Aluminum, cast or wrought	173.0
Bronze, cast	536.0
Copper-alloy	536.0
Copper sheet	558.0
Iron, cast	445.0
Iron, malleable	470.0
Iron, wrought	487.0
Lead, sheet	707.0
Steel, rolled, cast, copper bearing, silicon, nickel and stainless	490.0
Zinc	450.0

The weight of rolled shapes and of plates shall be computed on the basis of their nominal weights and dimensions, as shown on the approved plans and shop drawings, deducting for copes, cuts and open holes.

The weight of castings may be computed from the dimensions shown on the plans, with an addition of five percent for fillets and over-runs, or weighed on approved scales.

No allowance will be made for the weight of paint.

The weight of heads, nuts, single washers, DTIs when required, and threaded stick-through of all high tensile strength shop bolts will be included on the basis of the following weights:

Diameter of Bolt, Inches	Weight per 100 Bolts, Pounds
1/2	19.7
5/8	31.7
3/4	52.4
7/8	80.4
1	116.7
1 1/8	165.1
1 1/4	212.0
1 3/8	280.0
1 1/2	340.0

It shall be understood that the weight of the "threaded stick-through" of the bolts will be on the basis of the full-thread engagement. Full-thread engagement is

defined as being accomplished when the end of the bolt is flush with the outer face of the nut. At the discretion of the Contractor, the next longer standard length of bolt than that necessary to accomplish full-threaded engagement may be furnished and used, at no additional cost to the State.

The weight of weld metal will be computed on the basis of the theoretical volume from dimensions of the welds.

810.04.5--Deduction for Fabrication Inspection Cost Overruns. Under separate agreement, the Department will contract with a private company to provide inspection services for structural steel fabrication on this project. By this agreement a maximum amount payable, including a fixed fee will be established beyond which no funds will be authorized for payment without a Supplemental Agreement to this agreement.

The Department will be responsible for structural steel fabrication inspection costs not to exceed the established maximum amount payable including the fixed fee and any additional amount authorized for payment by Supplemental Agreement.

Structural steel fabrication inspection costs exceeding the above described amount will be deducted from monies due the Contractor under pay items 810-A, Structural Steel; 810-B, Steel Superstructure, and/or 810-C, Miscellaneous Bridge Appurtenances, as the case may be.

Ninety percent (90%) of the amount bid for structural steel items listed above will be the maximum amount paid the Contractor until such time final fabrication inspection costs have been determined and the Bridge Engineer notifies the Project Engineer to release full payment to the Contractor; otherwise, the Bridge Engineer will advise the Project Engineer of the amount to withhold from the Contractor's estimate to cover structural steel fabrication inspection costs that exceed the amount approved for payment by the Department.

810.05--Basis of Payment. Structural steel, subject to the deductions set out in Subsection 810.04.5, will be paid for at the contract unit price per pound. Steel superstructure and miscellaneous bridge appurtenances when shown as a pay item will be paid for at the contract lump sum price. The prices thus paid shall be full compensation for completing the work.

Payment will be made under:

810-A: Structural Steel *	-per pound
810-B: Steel Superstructure	- lump sum
810-C: Miscellaneous Bridge Appurtenances	- per pound or lump sum

* Specify the type if other than A 36

**SECTION 811 - BRONZE OR COPPER-ALLOY
BEARING AND EXPANSION PLATES**

811.01--Description. This work consists of furnishing and installing metal plates of the kind and type specified and in the manner shown on the plans.

811.02--Materials. Bearing and expansion plates, of the type and kind specified shall meet the requirements of Subsections 716.06 or 716.07 or 716.08, as applicable.

811.02.1--Bronze Plates. Plates shall be cast according to details shown on the plans. Sliding surfaces shall be planed parallel to the movement of the spans and polished unless detailed otherwise.

811.02.2--Copper-Alloy Plates. Plates shall be furnished according to details shown on the plans. Finishing of the rolled plates will not be required provided they have a plane, true, and smooth surface.

811.03--Construction Requirements. Bearing plates shall be accurately set in correct position as shown on the plans and shall have a uniform bearing over the whole area. Provision shall be made to keep the plates in correct position as the concrete is being placed.

811.04--Method of Measurement. Accepted bearing and expansion plates of the type specified will be measured by the pound. Unless otherwise provided, the measurements will be the Inspector's certified shop scale weight of plates placed in the structure. If specified in the contract, measurement will be computed weights, obtained by methods shown on the plans.

Lubricants will not be measured for separate payment.

811.05--Basis of Payment. Bearing and expansion plates will be paid for at the contract unit price per pound which price shall be full compensation for completing the work.

Payment will be made under:

811-A: Bronze Plates	- per pound
811-B: Copper-Alloy Plates	- per pound
811-C: Self-Lubricating <u>Type</u> Plates	- per pound

SECTION 812 - STEEL GRID FLOORING

812.01--Description. This work consists of constructing steel grid flooring, open or concrete-filled type as specified, in accordance with these specifications and in reasonably close conformity to the lines and grades shown on the plans or established.

812.02--Materials. Materials shall conform to the provisions of Subsection 717.05.

812.02.1--Arrangement of Sections. Where the main elements are normal to centerline of roadway, the units generally shall be of such length as to extend over the full width of the roadways up to 40 feet, but in every case the units shall extend over at least three panels. Where joints are required, the ends of the main floor members shall be welded at the joints over their full cross-sectional area or otherwise connected to provide full continuity.

Where the main elements are parallel to centerline of roadway, the sections shall extend over at least three panels, and the ends of abutting units shall be welded over their full cross-sectional area or otherwise connected to provide full continuity in accordance with the design.

812.02.2--Provisions for Camber. Unless otherwise provided on the plans, provision for camber shall be made as follows:

Steel units so rigid that they will not readily follow the camber required shall be cambered in the shop. To provide a bearing surface parallel to the crown of the roadway the stringers shall be canted or provided with shop-welded beveled bearing bars. If beveled bars are used, they shall be placed along the centerline of the stringer flange, in which case the design span length shall be governed by the width of the bearing bar instead of by the width of the stringer flange.

Longitudinal stringers shall be mill cambered or provided with bearing strips so that the completed floor after dead-load deflection will conform to the longitudinal camber shown on the plans.

812.02.3--Welding. All shop and field welding shall be in accordance with Subsection 810.03.5.

812.02.4--Repairing Damaged Galvanized Coatings. All galvanizing that has been chipped off or damaged in handling or transporting or in welding or riveting shall be repaired by field galvanizing by the application of a paste composed of approved zinc powder and flux with a minimum amount of water. The places to be coated shall be thoroughly cleaned, including removal of slag on welds, before the paste is applied. The surface to be coated shall first be heated with a torch to a sufficient temperature so that all metallics in the paste are melted when

applied to the heated surface. Extreme care shall be taken to see that the galvanized surfaces are not damaged by the torch. The flux in the paste will cause a black substance to appear on the surface of the coated parts, and this black substance shall be removed by wiping off with waste or by the quick application of cold water.

812.03--Construction Requirements.

812.03.1--Field Assembly. Areas of considerable size shall be assembled before the floor is welded to its supports. The main elements shall be made continuous, and sections shall be connected together along their edges by welding of bars or by riveting them. The connections shall meet with the approval of the Engineer. The rivets may be cold driven.

812.03.2--Connection to Supports. The floor shall be connected to its steel supports by welding. Before any welding is done the floor shall either be loaded to make a tight joint with full bearing, or it shall be clamped down. The location, length, and size of the welds shall be subject to the approval of the Engineer, but in no case shall they be less than the manufacturer's standards.

The ends of all the main steel members of the slab shall be securely fastened together at the sides of the roadway for the full length of the span by means of steel plates or angles welded to the ends of the main members, or by thoroughly encasing the ends with concrete.

812.03.3--Concrete Filler. Floor types with bottom flanges not in contact shall be provided with bottom forms of metal or wood to retain the concrete filler without excessive leakage.

Metal form strips, when used, shall fit tightly on the bottom flanges of the floor members and be placed in short lengths so as to extend only about one inch onto the edge of each support, but in all cases the forms shall be such as will result in adequate bearing of slab on the support.

The concrete shall be mixed, placed, and cured in accordance with Section 804. The concrete shall be thoroughly compacted by vibrating the steel grid floor. The vibrating device and the manner of operating it shall be subject to the approval of the Engineer.

812.03.4--Painting. Flooring furnished without galvanizing but with a shop coat of paint shall be given field coats of paint in accordance with Section 814.

When a structural steel plate is used on the bottom of a filled type floor, the bottom surface of the plate shall be given one shop coat, one field intermediate coat, and one field top coat of paint in accordance with Section 814.

812.04--Method of Measurement. Steel grid floor of the type specified will be measured by the square foot complete in place. No separate measurement will be made for galvanizing or painting and concrete filling when required.

812.05--Basis of Payment. Steel grid floor of the type specified, measured as prescribed above, will be paid for at the contract unit price per square foot, which price shall be full compensation for completing the work.

Payment will be made under:

812-A: Steel Grid Floor, Open Type	- per square foot
812-B: Steel Grid Floor, Concrete Filled	- per square foot

SECTION 813 - RAILING

813.01--General. This work consists of constructing bridge railing of the type specified in accordance with these specifications. Railing for bridges shall include all work constructed above the top of the bridge deck, curb, or sidewalk surface, as applicable.

813.02--Materials. All materials shall conform to the requirements of Division 700 or as specified on the plans. Unless otherwise specified, concrete shall be Class "AA" meeting the requirements of Section 804.

813.03--Construction Requirements.

813.03.1--Line and Grade. Lines and grades of railing shall be in reasonably close conformity to that shown on the plans and shall not follow any unevenness in the superstructure. Unless otherwise specified or shown on the plans, the railing, posts, and curbs on bridges, whether on horizontal grade, superelevated, or not shall be vertical.

813.03.2--Concrete Railing.

813.03.2.1--General. In no case shall concrete railings be placed until the centering or falsework for the span has been released and the span is self-supporting.

813.03.2.2--Railings Cast-In-Place. The portion of the railing or parapet which is to be cast in place shall be constructed in accordance with the requirements of Section 804. Special care shall be exercised to secure smooth and tight-fitting forms which can be rigidly held to line and grade and removed without injury to the concrete.

Forms shall either be of single width boards or other approved material or shall be lined with suitable material which has the approval of the Engineer. Form joints in plane surfaces will not be permitted.

All moldings, panel work, and bevel strips shall be constructed according to the detail plans with neatly mitered joints, and all corners in the finished work shall be true, sharp, and clean-cut and shall be free from cracks, spall, or other defects.

When railing is constructed by the slipform method, placement shall be as specified in Subsection 615.03.2.

813.03.2.3--Surface Finish. The surfaces of concrete railings shall conform to the requirements of Section 804.

813.03.2.4--Expansion Joints. Expansion joints shall be so constructed as to permit freedom of movement. After all other work is completed, all loose or thin shells of mortar likely to spall under movement shall be carefully removed from all expansion joints by means of a sharp chisel.

813.03.3--Metal Railing.

813.03.3.1--Construction. Fabrication and erection of ferrous metal shall be in accordance with the requirements of Section 810. In the case of welded railings, all exposed joints shall be finished by grinding or filling to give a neat appearance.

Fabrication and erection of non-ferrous material shall be in general conformity with applicable requirements of Section 810 and the specific requirements shown on the plans.

Metal railings shall be carefully adjusted prior to fixing in place to insure proper matching at abutting joints and correct alignment and camber throughout their length. Holes for field connections shall be drilled with the railing in place in the structure at the correct grade and alignment. Welding may be substituted for rivets in field connections with the approval of the Engineer.

Where galvanized ferrous metal railing is designated by the plans, the components shall be hot dip galvanized after fabrication in accordance with the requirements of the plans.

813.03.3.2--Painting. Painting shall conform to the requirements of Sections 710 and 814.

813.03.4--Wood Railings. Wood railings will be constructed and paid for under the provisions of Section 820.

813.04--Method of Measurement. Railing of the type specified will be measured by the linear foot within the nominal measuring points of spans at bridge ends. When the contract includes rails of various heights, the appropriate pay item decryption listed below will contain the rail height

813.05--Basis of Payment. Railing of the type specified, measured as prescribed above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for completing the work.
Payment will be made under:

- 813-A: Concrete Railing - per linear foot
- 813-B: Concrete-Steel Railing - per linear foot
- 813-C: Concrete-Aluminum Railing - per linear foot
- 813-D: Concrete Median Barrier Railing - per linear foot
- 813-E: Type Railing - per linear foot

SECTION 814 - PAINTING METAL STRUCTURES

814.01--Description. This work consists of furnishing all materials and painting of metal structures. It shall include, unless otherwise provided in the contract, the preparation of metal surfaces, application, protection and drying of the paint coatings, supplying of all tackle, scaffolding and other essentials necessary to complete the work in reasonably close conformity with the specifications and as indicated on the plans.

The Coating System will consist of one shop coat of inorganic zinc, one field intermediate coat of acrylic latex and one field top coat of acrylic latex. The shop coat, field intermediate coat and top coat shall each have a dry film thickness of not less than 3 mils nor more than 5 mils.

Touch-up paint for field repair of damaged areas in the inorganic zinc shop coat shall consist of epoxy mastic applied to a uniform dry film thickness of not less than 4 mils nor more than 6 mils.

814.02--Materials.

814.02.1--Shop Coat. Paint for the shop or prime coat shall be an inorganic zinc primer and meet the requirements of Subsection 710.03.

814.02.2--Acrylic Latex Intermediate Coat. Paint for the acrylic latex intermediate field coat shall meet the requirements of Subsection 710.03.

814.02.3--Acrylic Latex Top Coat. Paint for the acrylic latex top field coat shall meet the requirements of 710.03.

814.02.4--Epoxy Mastic Touch-Up Paint. Field touch-up paint for repair of damaged inorganic zinc shop coat shall meet the requirements of Subsection 710.03.

814.03--Construction Requirements.

814.03.1--Mixing of Paint. All paint shall be mixed in accordance with the manufacturer's printed instructions.

814.03.2--Weather Conditions. Solvent base paint shall not be applied when the surrounding air temperature is below 40°F. Waterborne paint shall not be applied when the surrounding air temperature is below 50°F. Paint shall not be applied when the surrounding air temperature is expected to drop to 32°F prior to drying of the paint. Paint shall not be applied when the metal is hot enough to cause blistering or produce a porous film. Paint shall not be applied when the steel surface is less than 5°F above the dew point nor shall it be applied in rain, snow, wind, fog, mist or when, in the opinion of the Engineer, conditions are otherwise unsatisfactory for the work.

814.03.3--Application.

814.03.3.1--Shop Coat. The coating shall be capable of being applied in accordance with specification requirements and shall be applied in accordance with the manufacturer's printed instructions.

After initial mixing, the paint shall be strained through a metal 30-60 mesh screen.

Stirring paddles on the mechanical mixing equipment shall reach to within one inch of the bottom of the paint container.

Airless spray equipment for application of inorganic zinc silicate paint shall provide pressure of not less than 2200 psi at the nozzle. The fluid hose between the pot and nozzle shall not be less than 3/8-inch inside diameter. Pressure may vary depending on tip size and pump.

Conventional spray equipment for application of inorganic zinc silicate paint shall provide pressure of not less than 10 psi at the pot and 30 psi at the nozzle.

814.03.3.2--Acrylic Latex Intermediate and Top Coats. All applications of the acrylic latex intermediate and top coats shall be in accordance with the manufacturer's printed instructions. The primer coat and the intermediate coat shall have dried a minimum of eight hours under normal conditions prior to

application of the intermediate and top coats, respectively. All surfaces shall be free of any soluble residue and surfaces on which the primer coat has been applied shall be free of excessive amounts of loose zinc before a subsequent coat is applied. Dust and dirt which may have accumulated on the surface shall be removed from the dried film with a soft brush or rag before application of a subsequent coat.

When applied by brushing or spraying, the coating shall deposit a uniform dry film thickness without running or sagging.

814.03.4--Removal of Paint. If any painting is unsatisfactory, it shall be removed and the metal thoroughly cleaned and repainted.

814.03.5--Thinning Paint. Paint shall be thinned only in strict accordance with the manufacturer's recommendations.

814.03.6--Painting Galvanized Surfaces. Prior to application of the acrylic latex field coats, galvanized surfaces shall be primed with Epoxy Mastic Touch-Up Paint as specified in Subsection 814.02.

814.03.7--Cleaning of Surfaces. Surfaces to be painted shall be thoroughly cleaned, removing rust, loose mill scale, dirt, oil or grease and other foreign substances.

All exposed and accessible surfaces of the metal shall be cleaned by sandblasting in accordance with the requirements of Steel Structures Painting Council SSPC-SP-10, Near White Blast Cleaning. The surface, regardless of starting condition, shall in the opinion of the Engineer or the Engineer's designated representative be at least equal to the appearance of Pictorial Swedish Standard Sa 2 1/2 of SIS 05 59 00, SSPC-VIS 1.

All rust blooms shall be removed by reblasting before coating. The surface shall be constantly and diligently examined ahead of the coating operations for any traces of rust, oil, grease or blemishes not permitted by the blast cleaning specifications.

814.03.8--Shop Painting. Unless otherwise specified, the shop coat shall be applied immediately after the steel work has been accepted by the inspector.

Shop contact surfaces shall not be painted. Field contact surfaces except for machine finished pins and holes shall receive a shop coat with a minimum dry film thickness of 1½ mils. All other surfaces which will be inaccessible after assembly or erection shall be given all required coats.

Surfaces which will be embedded or in contact with concrete shall not require painting unless otherwise noted on the plans. They may be painted in whole or

partially due to overspray provided the paint thickness does not exceed the requirements specified for adjacent areas.

Structural steel which is to be field welded shall not be shop painted within two inches of the field welds.

All surfaces of iron and steel castings except for machine finished pins and holes shall be given two shop coats of paint.

Erection marks for field identification of members and weight marks shall be painted on areas previously painted with the shop coat. Material shall not be loaded for shipment until it is thoroughly dry and no sooner than 24 hours after the paint has been applied.

814.03.9--Field Painting. When the erection work is complete, including all bolting and straightening of bent metal, all rust, scale, dirt, grease and other foreign material shall be removed.

As soon as the Engineer has approved all field welding and bolting, the surfaces from which the shop coat of paint has worn off or otherwise become defective shall be cleaned and reprimed with the specified touch-up paint prior to application of the intermediate coat.

Spans with concrete decks shall not be painted until after the deck is placed. All concrete spills and stains shall be washed from the structural steel prior to the mortar taking a set.

Surfaces to be bolted in contact and surfaces which will be in contact with concrete shall not have a field coat applied. When the paint applied for retouching the shop coat has thoroughly dried and the field cleaning has been satisfactorily completed, the intermediate coat shall be applied. After the intermediate coat has thorough dried, the top coat shall be applied. In no case shall a subsequent coat be applied until the previous coat has dried throughout the full thickness of the paint film.

To secure a maximum coating on edges of plates or shapes, bolt heads and other parts subjected to special wear and attack, the edges shall be stripped with a longitudinal motion and bolt heads with a rotary motion of the brush followed immediately by the general painting of the whole surface, including recoating of the edges and bolt heads.

If, in the opinion of the Engineer, traffic produces an objectionable amount of dust, the Contractor shall, at no additional costs to the State, allay the dust for the necessary distance on each side of the bridge and take any other precautions necessary to prevent dust and dirt from coming in contact with freshly painted surfaces or surfaces prepared for painting.

The Contractor shall protect pedestrian, vehicular and other traffic upon or underneath the bridge and also all portions of the bridge superstructure and substructure against damage or disfigurement by spatters, splashes and smirches of paint or paint material. Any such disfigurement shall be removed at the direction of and to the satisfaction of the Engineer.

814.03.10--Inspection. The completed shop coat shall be inspected by the Contractor for thickness by means of elcometer or other approved magnetic detector thickness gauge. Detection of insufficiently coated sections shall be marked and shall be coated over or touched up to establish the specified thickness.

All areas of the finished system deficient in thickness shall be coated over with the acrylic latex top coat paint to establish the specified thickness. Excessive thickness in the application of any coating evidenced by mudcracking will be cause for the affected area to be blast-cleaned and repainted.

Where rejection is due to poor workmanship or deficiency in the quality of the work or materials, the Contractor may be required to blast clean the entire defective sections of all previously applied materials prior to repainting.

Inspection shall be done in the presence of and to the satisfaction of the Engineer. The Engineer shall be provided access to the work to allow for proper inspection of the cleaning and painting at both the fabrication plant and the construction site.

814.04--Method of Measurement. Unless shown as a separate pay item in the proposal, painting of metal structures or members will not be measured for separate payment and the cost thereof shall be incidental to and included in the contract unit price(s) bid for other items.

814.05--Basis of Payment. When shown as a separate pay item in the proposal, painting of metal structures or members will be paid for at the contract lump sum price, which price shall be full compensation for completing the work.

Payment will be made under:

814-A: Painting of Metal Structure	- lump sum
814-B: Painting of Description	- lump sum

SECTION 815 - RIPRAP AND SLOPE PAVING

815.01--Description. This work consists of furnishing and placing a protective covering of erosion resistant material including geotextile fabric, where shown

on the plans for pier foundation protection, slope, or ditch protection. This work shall be in accordance with these specifications and in reasonably close conformity with the lines, grades and dimensions shown on the plans or established.

815.02--Materials. Materials shall conform to the following:

Geotextile shall meet the requirements of Subsection 714.13.

Aggregate for loose riprap, stone riprap for foundation protection, or that to be grouted shall consist of field stone, broken concrete, or rough, unhewn quarry stone as nearly rectangular in section as is practicable. The stone shall be dense, free of clay or shale seams, resistant to the action of air and water, and suitable in all other respects for the purpose intended. Quality requirements for rock to be furnished under these specifications will be checked or tested as determined by the Testing Engineer prior to use and subsequently if deemed appropriate.

Portland cement concrete aggregates, unless otherwise specified, shall conform to the applicable requirements of Section 703.

Cloth sacks for concrete riprap in bags shall be of suitable cloth or jute which will hold the concrete mixture without leakage when handled. The sacks shall be of uniform size and dimensions, approximately 19½ x 36 inches measured inside the seams when the sack is laid flat. Sound reclaimed cloth sacks meeting the specified requirements may be used.

Paper sacks for concrete riprap in bags shall be a polyester fiber type of scrim reinforced paper. The top and bottom of the sacks shall have a pasted valve. When filled, they shall measure approximately 13 inches wide, 20 inches long, and five inches thick. Perforations shall be overall on one-inch centers with a diameter of 3/32 inch to 1/8 inch per hole. Each bag shall fill a space of approximately 0.71 cubic feet with 38 bags required per cubic yard. Pre-packaged riprap will be accepted on certification from the manufacturer.

Stones for riprap, of the size specified, shall meet the requirements of Subsection 705.04.

Material used for sediment control stone shall be crushed stone meeting the requirements of Subsection 703.03 for Size No. 57.

815.03--Construction Requirements.

815.03.1--Construction Details. Prior to the construction of riprap or slope paving, the slopes or ground surface shall be shaped to lines and grades indicated on the plans or directed, and shall be thoroughly compacted by the use of mechanical or hand tamps. Unless otherwise stipulated or directed, slopes shall

not be steeper than the natural angle of repose of the material upon which riprap is to be constructed.

The outer edges and the top of the riprap or slope paving where the construction terminates shall be formed so that the surface of the riprap or slope paving will be embedded and even with the surface of the adjacent slope or ground, and the bottom of the riprap or slope paving shall be placed at least two feet below the natural ground surface unless otherwise directed.

All riprap or slope paving shall be started at the bottom of the slope and constructed upward.

No grout, bag riprap, or slope paving shall be placed during freezing weather or while there is frost on the ground. Prepackaged riprap in paper bags shall be immediately soaked with water after placement to insure hydration of the cement. In hot or dry weather grout and bag riprap shall be kept moist and protected from the sun for at least three days after placing. Replacement will be required if the bags do not set up to form a solid mass. Slope paving shall be cured in accordance with the provisions of Subsection 815.03.7.4.

815.03.2--Installation of Geotextile. When required by the contract, geotextile shall be placed in the manner and at locations shown on the plans. The area to receive the geotextile shall be prepared to a relatively smooth condition free of obstructions, depressions and debris. The geotextile shall be placed loosely without wrinkles or creases with the long dimension perpendicular to the channel. The strips shall be placed to provide a minimum overlap of 18 inches. Securing pins with washers shall be inserted through both strips of overlapped geotextile at mid-point and not greater than two foot intervals. Additional pins shall be installed throughout the geotextile as necessary to prevent any slippage. The geotextile shall be placed so that the upstream strip overlaps the downstream strip and the higher slope strip overlaps the lower strip. Each securing pin shall be pushed through the geotextile until the washer bears against the geotextile and secures it firmly.

The geotextile shall be protected from contamination and damage during installation and placement of the specified cover material. Riprap shall not be dropped from a height greater than three feet. Contaminated geotextile shall be replaced, and damaged geotextile shall be repaired or replaced as directed at no cost to the Department.

The geotextile shall be covered with a layer of the specified material within 14 calendar days after placement. Geotextile not covered within this time period shall be removed and replaced at the Contractor's expense if damage or deterioration is evident, as determined by the Engineer.

815.03.3--Loose Riprap. The stones shall be placed upon a slope not steeper than the natural angle of repose of the slope material. The stones shall be laid with close joints. The courses shall be laid from the bottom of the bank upward with the larger stones being placed in the lower courses. Interstices shall be filled with smaller stones and spalls.

815.03.4--Grouted Riprap. Grout for grouted riprap shall consist of one part of portland cement and three parts of approved sand thoroughly mixed with water to produce grout having a thick, creamy consistency.

The stones shall be of the size designated in the bid schedule of the contract and shall be placed in the same manner as specified for loose riprap. Care shall be taken during placing to keep earth or sand from filling the spaces between the stones.

After the stones are in place, the spaces between them shall be completely filled with grout from bottom to top and the surface swept with a stiff broom.

815.03.5--Stone Riprap for Foundation Protection. Stone riprap for pier and abutment protection shall range in size up to derrick stone and shall be graded from coarse to fine in such manner as to produce a minimum of voids. It shall be deposited where directed and stone deposited contrary to directions will be considered wasted and will not be paid for.

815.03.6--Concrete Riprap in Bags. Concrete riprap in cloth or jute bags shall consist of Class "D" concrete in approved bags and placed in conformity with contract requirements. Each bag shall be filled with approximately one cubic foot of concrete, securely tied, and immediately placed in the work and lightly trampled to cause them to conform with the slope or section required with adjacent bags in place. Unless otherwise specified in the contract, the bagged concrete shall be packed in such a manner as to give a reasonably uniform thickness of approximately 12 inches and shall be lapped and staggered as directed.

Pre-packaged riprap in paper bags shall be filled with kiln-dried mixture of portland cement and sand, or cement, sand and gravel with a ratio of three parts sand or sand and gravel to one part portland cement. The bags shall be placed to conform with the slope or required section and with adjacent bags in place. The bags shall be lapped and staggered as directed.

When shown on the plans, pipe headwalls shall be constructed of concrete riprap in bags in accordance with these specifications and the plan details. In this construction, it is essential that the successive tiers are securely "keyed" by lapping. The bags shall be lapped one-half their length, when practicable.

815.03.7--Slope Paving. Concrete slope paving shall be constructed in a single layer in conformity with the design dimensions and details indicated on the plans.

815.03.7.1--Forms. Forms shall be wood or metal of sufficient strength to withstand the pressure of the concrete without bulging. They shall be adequately and securely staked true to line and grade.

815.03.7.2--Mixing and Placing Concrete. Unless otherwise stipulated, the concrete used in this construction shall be Class "C" Concrete, mixed and placed in accordance with the provisions and requirements of Section 804, except that volumetric batching may be used. Mixers of less than one bag rated capacity shall not be used.

815.03.7.3--Finishing. Concrete after spreading, shall be tamped and puddled until it is compact and sufficient mortar has been flushed to the surface so that it can be finished smooth with a wooden float. All edges shall be neatly edged using an approved short radius sidewalk edge.

815.03.7.4--Curing. After the concrete has set sufficiently, the surface shall be protected from premature drying by covering as soon as possible with a satisfactory material such as wetted burlap or wetted cotton mats and kept moist for a minimum of three days, or cured by other approved methods. Other approved methods include liquid membrane compound as set out in Subsection 713.01.2 and applied in accordance with the provisions of Subsection 501.03.20, except that approved hand spray methods will be acceptable, and white polyethylene sheeting conforming with the requirements of Subsection 713.01.3 and applied in accordance with the provisions of Subsection 501.03.20. Both liquid membrane compound and polyethylene sheeting shall be maintained in place and intact for a minimum period of three days.

815.03.7.5--Soil Sterilization. Prior to placing slope pavement, the areas beneath the pavement shall receive soil sterilization treatment as set out in Subsection 616.03.2.

815.03.8--Cleaning Up. Upon completion of the work, the surface of the riprap or slope paving shall be cleaned, surplus material and debris removed and disposed of as directed, and the site of the work left in a neat presentable condition.

815.04--Method of Measurement. Loose riprap will be measured in square yards or tons, as specified. Sediment control stone will be measured by the cubic yard (LVM) or ton, as specified. The pay area will be determined by using the outside dimensions of the area covered as directed. Tons or fraction thereof will be determined by railway weights or other satisfactory and approved weighing methods. Stone placed contrary to directions will not be paid for.

Measurement or payment will not be made for grout, and the cost thereof shall be included in the compensation for grouted riprap.

Concrete riprap in cloth or jute bags will be measured in cubic yards as the quantity received or manufactured at the site of the work and acceptably placed in bags as required, but from the amount received or manufactured at the site, there will be deducted all excess determined by the Engineer to have been wasted or placed to unauthorized dimensions.

The cubic yards of pre-package riprap in paper bags will be determined from the actual count of bags placed and accepted based on 38 bags per cubic yard.

Slope paving will be measured by the cubic yard computed using the dimensions shown on the plans, except that if authorized revisions are made in the finish grade or the configuration of the slope pavement, computations will be made considering the changed dimensions.

Geotextile complete in place and accepted will be measured by the square yard of surface area covered. Any overwidth of material installed and additional material required for laps or sewing will not be measured. No separate payment shall be made for shipping, handling, storage, protection, fabrication, securing pins, or installation; the cost of which shall be included in the contract price for geotextile fabric.

815.05--Basis of Payment. Loose riprap will be paid for at the contract unit price per square yard or ton. Sediment control stone will be paid for at the contract unit price per cubic yard or ton. Grouted riprap will be paid for at the contract unit price per square yard. Concrete riprap in bags and concrete slope paving will be paid for at the contract unit price per cubic yard. Geotextile will be paid for at the contract unit price per square yard. Such payment shall be full compensation for completing the work.

Payment will be made under:

815-A: Loose Riprap, <u>Size</u>	- per square yard or ton
815-B: Grouted Riprap	- per square yard
815-C: Concrete Riprap in Bags	- per cubic yard
815-D: Concrete Slope Paving	- per cubic yard
815-E: Geotextile under <u>Description</u> , Type <u>*</u> , AOS <u>*</u>	- per square yard
815-F: Sediment Control Stone	- per cubic yard or ton

* When not designated, see Subsection 714.13.

SECTION 816 - MAINTENANCE PAINTING OF METAL STRUCTURES

816.01--Description. This work consists of furnishing all materials, equipment and labor for the cleaning and painting of metal structures. It shall include, unless otherwise provided in the contract, the preparation of metal surfaces, the application, protection and drying of the paint coatings, supplying all tackle, scaffolding and other essentials necessary to complete the work in accordance with the specifications and as specified on the plans.

816.02--Materials. The coating system selected for maintenance painting must be lead free, VOC compliant and must be listed on the Department's Approved List of Materials under "Approved Coating Systems for Upgrading Existing Coatings by Maintenance Forces". The coating system shall consist of three coats as follows; an approved primer coat paint, intermediate coat paint and a top coat paint. The substitution of a primer, intermediate or top coat paint from one approved coating system to another is not permitted. The integrity of each approved coating system must be maintained.

When the project requires the painting of both new and existing metal structures, the different painting systems selected shall be from the same manufacturer and shall have the same top coat color.

816.03--Construction Requirements.

816.03.1--Weather Limitations. Solvent base paint shall not be applied when the surrounding air temperature is below 40°F. Waterborne paint shall not be applied when the surrounding air temperature is below 50°F. Paint shall not be applied when the surrounding air temperature is expected to drop to 32°F prior to drying of the paint. Paint shall not be applied when the metal is hot enough to cause blistering or produce a porous film. Paint shall not be applied when steel surface is less than 5°F above the dew point nor shall it be applied in rain, snow, wind, fog, mist or when, in the opinion of the Engineer, conditions are otherwise unsatisfactory for the work.

816.03.2--Pollution Control During Surface Preparation And Repainting. Generated debris must be confined to the immediate area of the structure. Appropriate screens and barriers must be erected to protect pedestrian and vehicular traffic during waterblasting and painting operation. Overspray must be kept to a bare minimum.

816.03.3--Surface Preparation. Surface preparation will include waterblasting the entire surface followed by spot cleaning with hand tools to remove any remaining loose or flaking paint or rust, dirt, oil, grease and/or other deleterious matter from the steel surface. Tightly bonded paint is not to be removed and it is not necessary to remove tightly bonded rust.

In areas containing a heavy coating of oil, grease and/or deleterious material that cannot be cleaned by waterblasting, use BIOACT AE-O or an approved biodegradable solvent that is environmentally equivalent. Brush or mop the solvent on the surface with a rubbing action to loosen the film. Wipe off with a clean dry cloth and then rinse by waterblasting. Repeat as necessary until clean. The cleanliness of the surface shall be approved by the Project Engineer or a designated representative prior to beginning painting operations.

816.03.3.1--Waterblasting. The waterblasting unit must be capable of operating at pressures up to 4,000 psi at a water flow rate up to 10 gpm. The unit must be equipped with a water filter, pressure gauge, nozzle with 1/8-inch orifice or one that will provide a jet stream of water, and sufficient length of hydraulic hose. The unit shall be equipped with a deadman control valve or other control valves that will provide automatic shut-off by release of the trigger. Water for blasting must be potable water to prevent damage to the pump and to insure a clean surface on the steel. During waterblasting operation, wood, insulation, electrical, instrumentation, etc., must be protected. After waterblasting, remove any remaining loose paint, loose rust and rust scale with wire brushes or other methods as necessary. Using the waterblast unit or compressed air, remove the loose debris generated from the hand tool cleaning operation. To prevent recontamination of the steel surface, the surface preparation operation should not be completed more than eight hours in advance of the painting operation. Should any recontamination occur prior to painting, repeat surface preparation procedures as necessary for removal. Before painting, the surfaces must be clean and dry. To enhance drying of the surfaces, compressed air may be used.

816.03.3.2--Safety and Clean-Up. During the cleaning of the existing steel, the Contractor may be dealing with hazardous material and the Contractor will be responsible for the health and safety of employees. The Contractor shall provide such items as protective clothing and respirators and make certain that they are used. The Contractor shall also be responsible for the maintenance and/or replacement of these items. The Contractor is advised that safety precautions for workers during each phase of work shall be in compliance with present OSHA standards.

The Contractor shall take necessary precautions to prevent an excessive amount of removed materials from falling beneath the structure. General debris must be confined to the immediate area of the structure. Appropriate measures shall be taken to protect the traveling public during surface preparation and painting operations.

The Contractor shall clean the area of excessive debris generated from cleaning and properly dispose of it at an approved landfill.

The Contractor shall take necessary steps to become familiar with any applicable Federal, State or local regulations and take the necessary actions for compliance when applicable to any portion of the required work.

816.03.4--Packaging and Marking. Multiple component paints shall be furnished in premeasured packages so as to form one unit of mixed paint when mixed with the vehicle in its container.

The containers for all paints shall be coated as necessary to prevent attack by the paint. Each container shall bear a label with the following information shown thereon: name and address of manufacturer, trade mark or trade name, kind of paint, date of manufacture and lot number, mixing instructions and equipment clean up instructions. The VOC content shall be stated either on the label, product data sheet, or Material Safety Data Sheet.

816.03.5--Acceptance Procedure. Prior to use, the Contractor must furnish the Engineer a certificate from the manufacturer, covering each lot of paint in the shipment, attesting that the paint in the shipment conforms to the same formula as that originally approved by the Department.

Final acceptance of the paint will be based on results of tests performed by the Central Laboratory on samples obtained by the Department's representative prior to or after delivery. The use of any lot of paint prior to its final acceptance shall be prohibited.

816.03.6--Mixing, Thinning and Application. All paint shall be mixed and applied in accordance with the manufacturer's printed instructions. Paint shall be thinned only under conditions which follow strict accordance with the manufacturer's recommendations.

At the Engineer's request, the paint manufacturer's technical representative who is certified by the National Association of Corrosion Engineers (NACE) shall be present at the job site at the beginning of each separate coating operation as needed to provide technical expertise in the application of the field coats. This technical expertise shall be provided without additional cost to the Department. The Contractor shall be responsible for arranging for the presence of the manufacturer's technical representative.

Apply the paint to the Wet Film Thickness (WFT) that will obtain the Dry Film Thickness (DFT) required for the film being applied. The DFT required for each paint film of each approved coating system is set out in the Department's Approved List of Materials.

A subsequent coat shall not be applied until the previous coat has dried throughout the film thickness.

To secure a maximum coating on edges of plates or shapes, rivets, bolt heads and other parts subjected to special wear and attack, the edges shall be stripped with a longitudinal motion and the rivets and bolt heads with a rotary motion of a brush followed immediately by general painting of the whole surface, including recoating of the edges, rivets and bolt heads.

If, in the opinion of the Engineer, traffic produces an objectionable amount of dust, the Contractor shall, at no additional costs to the State, allay the dust for the necessary distance on each side of the bridge and take any other precautions necessary to prevent dust and dirt from coming in contact with freshly painted surfaces or surfaces prepared for painting.

The Contractor shall protect pedestrian, vehicular and other traffic upon or underneath the bridge and also all portions of the bridge superstructure and substructure against damage or disfigurement by splatters, splashes and smirches of paint or paint material. Any such disfigurement shall be removed at the direction of and to the satisfaction of the Engineer.

816.03.7--Inspection. The Contractor shall measure the paint thickness with an elcometer or other approved magnetic detector thickness gauges. All areas of the finished system deficient in thickness shall be coated over with the finish paint to establish the specified thickness. Excessive thickness in the application of either coating evidenced by mudcracking will be cause for the effected area to be stripped of paint, cleaned and repainted.

Where rejection is due to poor workmanship or deficiency in the quality of the work or materials, the Contractor may be required to strip the entire defective sections of all previously applied materials and clean prior to repainting.

Inspection shall be done in the presence of and to the satisfaction of the Engineer.

816.04--Method of Measurement. Maintenance painting of structures and members will be measured lump sum or per each as provided in the contract.

816.05--Basis of Payment. Maintenance painting of structures and members will be paid for at the contract unit price per each or lump sum, which price will be full compensation for preparation of the surface, for furnishing and applying all materials and for all labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under:

816-A: Maintenance Painting of Metal Structures	- lump sum
816-B: Maintenance Painting of Metal Structure, <u>Location / Description</u>	- per each

SECTION 820 - TIMBER STRUCTURES

820.01--Description. This work consists of constructing timber structures in conformity with these specifications and in accordance with lines, grades, dimensions, and details shown on the plans.

820.02--Materials.

820.02.1--Lumber and Timber. Lumber and timber shall conform to the requirements of Section 718, and in the case of exposed permanent structures shall be treated as set out therein. Certain portions of untreated timber shall be coated as set out hereinafter and as may be shown on the plans.

820.02.2--Rods, plates, Eyebars, and Shapes. Rods, plates, eyebars, and shapes shall be of structural steel conforming to the requirements of Section 717.

820.02.3--Castings. Castings shall be cast steel or gray-iron, as specified, conforming to the requirements of Subsections 716.02 or 716.04.

820.02.4--Hardware. Machine bolts, drift bolts, and dowels may be either wrought iron or medium steel. Washers may be cast ogee or malleable castings, or they may be cut from medium steel or wrought iron plate, as specified.

Unless otherwise specified, machine bolts shall have square heads and nuts. Nails shall be cut or round wire of standard form. Spikes shall be cut or wire spikes, or boat spikes, as specified.

Nails, spikes, bolts, dowels, washers, and lag screws shall be galvanized unless otherwise specified.

820.03--Construction Requirements.

820.03.1--Storage of Material. Lumber and timber stored on the site shall be kept in orderly piles or stacks. Untreated material shall be open-stacked on supports at least 12 inches above the ground surface to avoid absorption of ground moisture and to permit air circulation, and it shall be so stacked and stripped as to permit free circulation of air between the tiers and courses. It will be advisable in particular cases for the Engineer to require protection from the weather by a suitable covering. On glued laminated structural members that are not to be treated, an approved end sealer shall be applied after end trimming of each completed member.

820.03.2--Installing Timber Piling.

820.03.2.1--Driving Piling. Timber piles shall be driven in accordance with the requirements of Subsection 803.02.6, except as modified herein.

820.03.2.2--Pile Hammer Formulas. Pile hammer formulas shall be per the requirements of Subsection 803.03.9.6, except the use of gravity or drop hammers shall be allowed. In the absence of loading test, safe bearing values for piles driven with a gravity or drop hammer shall be determined by the following formula:

$$P = \frac{2WH}{S+1.0} \text{ for gravity or drop hammers}$$

820.03.3--Timber Connectors. Timber connectors shall be one of the following types, as specified on the plans: the split ring, the toothed ring, the shear plate, or the spike grid. The split ring and the shear plate shall be installed in pre-cut grooves of dimensions as given herein or as recommended by the manufacturer. The toothed ring and the spike grid shall be forced into the contact surface of the timbers joined by means of pressure equipment. All connectors of this type at a joint shall be embedded simultaneously and uniformly.

Fabrication of all structures using connectors shall be done prior to treatment. When prefabricated from templates or shop details, bolt holes shall not be more than 1/16 inch from required placement. Holes for round drift bolts shall be bored with a bit 1/16 inch less than the bolt to be used. The diameter for square drift bolts shall be equal to the least dimension of the bolt. Holes for machine bolts shall be bored with a bit the same diameter as the bolt. Bolt holes shall be bored perpendicular to the face of the timber.

Timber after fabrication shall be stored in a manner which will prevent changes in the dimensions of the members before assembly.

Dimensions of material and details not otherwise specified shall meet with the approval of the Engineer.

820.03.4--Treated Timber.

820.03.4.1--Handling. Treated timber shall be carefully handled without sudden dropping, breaking of outer fibers, bruising, or penetrating the surface with tools. It shall be handled with rope slings. Cant hooks, peaveys, spikes, or hooks shall not be used. Prior to driving, the timber piling shall not be handled in such a manner that it is subjected to excessive and undue abuse that might produce splitting, splintering or brooming of the wood.

820.03.4.2--Placement. All cutting, framing, and boring of treated timber shall be done before treatment insofar as practicable. When treated timbers are to be

placed in waters infected by marine borers, untreated cuts, borings, or other joint framings below high water elevation shall be avoided.

820.03.4.3--Cuts and Abrasions. All cuts in treated piles or timbers, and all abrasions, after having been carefully trimmed, shall be covered with two applications of a mixture of 60 percent creosote oil and 40 percent roofing pitch, or brush coated with at least two applications of hot creosote oil and covered with hot roofing pitch.

820.03.4.4--Bolt Holes. All bolt holes bored after treatment shall be treated with creosote oil by means of an approved pressure bolt hole treater. Any unfilled holes, after being treated with creosote oil, shall be plugged with creosoted plugs.

820.03.4.5--Temporary Attachment. Whenever, with the approval of the Engineer, forms or temporary braces are attached to treated timber with nails or spikes, the holes shall be filled by driving galvanized nails or spikes flush with the surface or plugging holes as required for bolt holes.

820.03.5--Untreated Timber. In temporary structures of untreated timber the following surfaces shall be thoroughly coated with two coats of hot creosote oil before assembling: ends, tops, and all contact surfaces of sills, caps, floor beams, and stringers; and all ends, joints, and contact surfaces of bracing and truss members. The back faces of bulkheads and all other timber which is to be in contact with earth, metal or other timber shall be similarly treated.

Bolts passing through non-resinous wood shall be galvanized.

820.03.6--Treatment of Pile Heads. The heads of treated timber piles shall be protected as specified on the plans. If not specified, the fabric covering shall be used. The heads of timber piles, when the nature of the driving will unduly injure them, shall be protected by driving caps. When the area of the head of a timber pile is greater than that of the face of the pile hammer, a suitable cap shall be provided to distribute the blow of the hammer throughout the cross section of the pile. Fresh heading of a timber pile is recommended prior to driving. The head shall be cut square and shall be shaped or chamfered to prevent splitting at its periphery. Heads of all piling shall be square and a driving cap shall be provided to hold the axis of the pile in line with the axis of the hammer.

820.03.6.1--Cutting Off of Timber Piles. The tops of all piling shall be sawed to a true plane, as shown on the plans, and at the elevation fixed by the Engineer. Piles which support timber caps or grillage shall be sawed to conform to the plane of the bottom of the superimposed structure. In general, the length of pile above the cut-off elevation shall be sufficient to permit the complete removal of all material injured by driving, but piles driven to very nearly the cut-off elevation shall be carefully adzed or otherwise freed from all broomed, splintered

or otherwise injured material. Pile heads, after cutting to receive the caps and prior to placing the caps, shall be treated in accordance with Subsection 820.03.6.

820.03.6.2--Defective Piles. All piles damaged because of internal defects or by improper driving, driving out of the proper location, or driving below the specified elevation shall be corrected at no additional costs to the State by one of the following methods approved by the Engineer for the pile in question:

- A. The pile shall be withdrawn and replaced by a new, and if necessary, a longer pile.
- B. A second pile shall be driven adjacent to the defective or low pile.
- C. A sufficient portion of the footing shall be extended to properly embed the pile. Timber piles shall not be spliced. All piles pushed up by the driving of adjacent piles or by any other cause shall be driven down again.

820.03.6.3--Metal Covering. The sawed surface shall be covered with three applications of a mixture of 60 percent creosote oil and 40 percent roofing pitch or thoroughly brush-coated with three applications of hot creosote oil and covered with hot roofing pitch. Before placing the cap, a sheet of 12 gauge, 0.028-inch zinc of good commercial quality or a sheet of 26 gauge iron or steel of the quality of ASTM Designation: A 525 and galvanized each side shall be placed on each pile head. The sheet shall be of sufficient size to project at least four inches outside of the pile, and it shall be bent down, neatly trimmed and securely fastened to the face of the pile with large headed galvanized roofing nails.

820.03.6.4--Fabric Covering. The heads of all piles shall be covered with alternate layers of hot pitch and loosely woven fabric similar to membrane waterproofing, using four applications of pitch and three layers of fabric. The cover shall measure at least six inches more in dimensions than the diameter of the pile and shall be neatly folded down over the pile and secured by large headed galvanized nails or by binding or serving with not less than seven complete turns of galvanized wire securely held in place by large-headed galvanized nails and staples. The edges of the fabric projecting below the wire wrapping shall be trimmed to present a workmanlike appearance.

The heads of untreated piles shall be given one of the following treatments, as may be specified or directed by the Engineer:

- A. The sawed surface shall be thoroughly brush-coated with two applications of hot creosote oil.
- B. The sawed surface shall be heavily coated with paint, after which it shall be covered with cotton duck of a least eight-ounce weight, which shall be

folded down over the sides of the pile and firmly secured thereto with large-headed roofing nails. The edges of the duck shall be trimmed to give a workmanlike appearance. The duck shall then be waterproofed by being thoroughly saturated and coated with one or more applications of red lead paint.

820.03.7--Holes for Bolts, Dowels, Rods and Lag Screws. Holes for round drift bolts and dowels shall be bored with a bit 1/16 inch less in diameter than the bolt or dowel to be used. The diameter of holes for square drift bolts or dowels shall be equal to the least dimension of the bolt or dowel.

Holes for machine bolts shall be bored with a bit the same diameter as the bolt, except as otherwise provided in Subsection 820.03.3.

Holes for rods shall be bored with a bit 1/16 inch greater in diameter than the rods.

Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread.

820.03.8--Bolts and Washers. A washer, of the size and type specified, shall be used under all bolt heads and nuts which would otherwise come in contact with wood.

The nuts of all bolts shall be effectively locked after they have been finally tightened.

820.03.9--Framing. All lumber and timber shall be accurately cut and framed to a close fit in such manner that the joints will have even bearing over the entire contact surfaces. Mortises shall be true to size for their full depth, and tenons shall fit snugly. No shimming will be permitted in making joints, nor will open joints be accepted.

820.03.10--Pile Bents. Pile bents shall be constructed in accordance with applicable provisions of Section 803.

820.03.11--Framed Bents.

820.03.11.1--Mud Sills. Untreated timber used for mud sills shall be of heart cedar, heart cypress, redwood, or other durable timber. Mud sills shall be firmly and evenly bedded to solid bearings and tamped in place.

820.03.11.2--Concrete Pedestals. Concrete pedestals for the support of framed bents shall be carefully finished so that the sills or posts will take even bearing on them. Dowels of at least 3/4-inch diameter and projecting at least six inches

above the tops of the pedestals shall be set in them when they are cast for anchoring the sills or posts.

820.03.11.3--Sills. Sills shall have true and even-bearing on mud sills, piles, or pedestals. They shall be drift-bolted to mud sills or piles with bolts of not less than 3/4-inch diameter and extending into the mud sills or piles at least six inches. When possible, all earth shall be removed from contact with sills so that there will be free air circulation around them.

820.03.11.4--Posts. Posts shall be fastened to pedestals with dowels of not less than 3/4-inch diameter extending at least six inches into the posts.

Posts shall be fastened to sills by one of the following methods, as indicated on the plans:

- A. By dowels of not less than 3/4-inch diameter extending at least six inches into posts and sills.
- B. By drift bolts of not less than 3/4-inch diameter driven diagonally through the base of the post and extending at least nine inches into the sill.

820.03.12--Caps. Timber caps shall be placed, with ends aligned, in a manner to secure an even and uniform bearing over the tops of the supporting posts or piles. All caps shall be secured by drift bolts of not less than 3/4-inch diameter extending at least nine inches into the posts or piles. The drift bolts shall be approximately in the center of the post or pile.

820.03.13--Bracing. The ends of bracing shall be bolted through the pile, post or cap with a bolt of not less than 5/8-inch diameter. Intermediate intersections shall be bolted, or spiked with wire or boat spikes, as indicated on the plans. In all cases spikes shall be used in addition to bolts.

820.03.14--Stringers. Stringers shall be sized at bearings and shall be placed in position so that knots near edges will be in the top portions of the stringers.

Outside stringers may have butt joints with the ends cut on a taper, but interior stringers shall be lapped to take bearing over the full width of the floor beams or cap at each end. The lapped ends of untreated stringers shall be separated at least 1/2 inch for the circulation of air and shall be securely fastened by drift-bolting where specified. When stringers are two panels in length the joints shall be staggered.

Cross-bridging between stringers shall be neatly and accurately framed and securely toe nailed with at least two nails in each end. All cross-bridging members shall have full bearing at each end against the sides of stringers. Unless

otherwise specified in the contract, cross-bridging shall be placed at the center of each span.

820.03.15--Plank Floors. Unless otherwise specified, planks used in this construction shall conform to the requirements set forth in Subsection 820.02.1.

Single plank floor shall consist of a single thickness of plank supported by stringers or joists. The planks shall be laid heart side down, with 1/4-inch openings between them for seasoned material and with tight joints for unseasoned material. Each plank shall be securely spiked to each joist. The planks shall be carefully graded as to thickness and so laid that no two adjacent planks shall vary in thickness by more than 1/4 inch.

Two-ply timber floors shall consist of two layers of flooring supported on stringers or joists. The lower course shall be pressure treated with creosote oil. The top course may be laid either diagonally or parallel to the centerline of roadway as specified, and each floor piece shall be securely fastened to the lower course. Joints shall be staggered at least three feet. If the top flooring is placed parallel to the centerline of the roadway, special care shall be taken to securely fasten the ends of the flooring. At each end of the bridge these members shall be beveled.

820.03.16--Laminated or Strip Floors. The strips shall be of the grade required in Section 718. The strips shall be placed on edge at right angles to the centerline of the roadway. Each strip shall be spiked to the preceding strip at each end and at approximately 18-inch intervals with the spikes driven alternately near the top and bottom edges. The spikes shall be of sufficient length to pass through two strips and at least half-way through the third strip.

If timber supports are used, every other strip shall be toe-nailed to each timber support. The size of the spikes shall be as shown on the plans. When specified on the plans, the strips shall be securely attached to steel supports by the use of approved galvanized metal clips. Care shall be taken to have each strip vertical and tight against the preceding one and bearing evenly on all the supports.

820.03.17--Wheel Guards and Railing. Wheel guards and railing shall be accurately framed in accordance with the plans and erected true to line and grade. Unless otherwise specified, wheel guards, rails and rail posts shall be surfaced four sides, S4S. Wheel guards shall be laid in sections at least 12 feet long.

820.03.18--Countersinking. Countersinking shall be done wherever smooth faces are required. Horizontal recesses formed for countersinking shall be painted with hot creosote oil, and after the bolt or screw is in place shall be filled with hot pitch.

820.03.19--Painting. Rails and rail posts of untreated timber, or timber treated with preservative salts, shall be painted with three coats of paint.

Parts of the structure, other than rails and rail posts, which are to be painted, will be designated on the plans or in the special provisions.

Metal parts, except hardware, shall be given one coat of shop paint and after erection two coats of field paint as specified on the plans.

820.04--Method of Measurement. Timber remaining in the structure will be measured by the thousand feet board measure (MBM) which shall include the cost of all hardware, galvanizing, paint and painting. Computations of the amount of lumber and timber in the structure will be based on nominal sizes and the lengths indicated on the plans.

Piling will be measured in accordance with Subsection 803.04.

Metal parts, other than hardware, will be measured in accordance with Section 810.

820.05--Basis of Payment. Timber will be paid for at the contract unit price per thousand feet board measure, which price shall be full compensation for completing the work. Acceptable piling will be paid for at the respective contract prices per linear foot for the types and sizes specified, which price shall be full compensation for completing the work.

Payment will be made under:

820-A: Treated Timber	- per MBM
820-B: Untreated Timber	- per MBM
820-C: Untreated Timber Piling	- per linear foot
820-D: Treated Timber Piling	- per linear foot

SECTION 822 - NEOPRENE EXPANSION JOINTS

822.01--Description. This work consists of furnishing and installing neoprene expansion joints in accordance with these specifications and details shown on the plans.

822.02--Materials. Expansion joints shall meet the requirements of Subsection 707.07.

822.03--Construction Methods. Expansion joints shall be installed in accordance with the manufacturer's recommendations. The expansion material shall seal the deck surface, gutters and curbs to prevent moisture or other contaminants from leaking through the joints. Anchor bolts shall be cast-in-place or drilled and grouted at a spacing recommended by the manufacturer. The expansion material shall be installed in such a manner that the top surface of the material will be parallel to but not protrude above the roadway or bridge surface.

822.04--Method of Measurement. Neoprene expansion joints of the types specified will be measured in linear feet.

822.05--Basis of Payment. Neoprene expansion joints will be paid for at the contract unit price per linear foot, which price shall be full compensation for completing the work.

Payment will be made under:

822-A: ____ " Neoprene Expansion Joint, Type____ - per linear foot

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