

STATE OF MAINE



Department of Transportation

Standard Specifications Highways and Bridges

Revision of April 1995

FOREWORD

This edition of the State of Maine, Department of Transportation, Standard Specifications, Highways and Bridges will be used for projects designed and bid in either metric or English units. The units are not necessarily equal, for example 1 cubic yard equals 0.764 555 m³. The individual using these Standard Specifications must familiarize themselves with the proper units to use for the project they are working with.

The metric unit or specification is expressed first with the English unit or specification following in brackets, for example:

Pay Item	Pay Unit
203.20 Common Excavation	cubic meter [Cubic Yard]

The Contractor, when bidding shall be responsible for ascertaining whether English or metric units are used in the project and determining the proper bid for the unit shown. The Contractor shall also be responsible for training staff and subcontractors in the metric system. All work on projects advertised using the metric system will be done using that system.

All metric units are expressed as symbols. A "soft" conversion is one in which the inch-pound measurement is mathematically converted to its exact (or nearly exact) metric equivalent. "Soft" conversions are used primarily to convert dimensions of proprietary products which would require an extensive retooling expenditure if dimensional changes were made. With a "hard" conversion, the inch-pound dimension is approximated with a new rounded, rationalized metric number that is easy to work with and remember. Most of the conversions have been of the "hard" variety. Metric values presented, when hard converted, do not equal the english unit value presented in brackets.

The accompanying table show the common metric units, conversions and symbols used in these Specifications.

REVISIONS TO STANDARD SPECIFICATIONS
APRIL, 1995

The following is a list of the significant changes in the April 1995 edition of the Standard Specification book. This list is not part of the specifications, but is included only for convenience of the user. No claims will be accepted because of changes not included in this list.

The major change throughout the specification book is that of metricating all english units and displaying both metric and english units. Refer to the Forward in the specification book for further clarification.

109.12	Asphalt escalator included
201.01	Definition of single tree and stump
201.09	Alternate plan quantity measurement for clearing
203.18	Plan quantity measurement for backfill
203.18	Excavation measurement
204.10	Shoulder rehabilitation measurement
204.11	Shoulder rehabilitation payment
205.06	Shoulder reconstruction measurement
205.11	Shoulder reconstruction payment
206.04	Major structures excavation
206.05	Structural rock excavation
301	Plant Mix Base Course Section deleted
401.02	Bitumen content aim
401.02	Minimum stability requirement
401.081	Stockpile requirements
401.082	Thermometric equipment
401.082	Batch counter
401.082	25 kg masses for scale testing
425.05	Hot recycled testing
425.09	Weight tickets
460.072	Automatic ticket printer required
501.07	Pile testing and acceptance
501.08	Test piles
501.09	Pile splicing
501.11	Piling method of measurement
502.05	Class P concrete added
502.05	Calcium nitrite added to class P concrete
502.05	High range water reducing admixture
502.05	Minimum cement content
502.06	Mixer drum water measuring system
502.06	Admixture sequencing
502.06	25 kg masses for scale testing
502.10	Construction of falsework
503.051	Epoxy-coated reinforcing steel testing
504.28	Connections using high strength bolts
504.49	Field welder certification
506	Painting structural steel section deleted
507.07	Bridge railing basis of payment

511.04	Sedimentation basins for cofferdams
512.05	French drains basis of payment
521	Finger joint & fabric trough section added
523	Pot bearings section added
524	Temporary structural supports section added
525.02	Granite masonry caulking
525.08	Granite masonry joints
535.221	Precast concrete stripping strength
605.02	Polyethylene underdrain tubing coupling
607.05	Chain link fence bracing
609	Concrete curb added
614	Fertilizing grassed areas section deleted
618.03	Ground limestone application
620.03	Geotextile placed under riprap
624	Project marker section deleted
627.06	Pavement making lines increased thickness
631.07	Foreman pay item included
639.04	Field office accessibility standards
639.05	Soils testing facilities equipment
639.06	Bituminous testing facilities equipment
639.07	Concrete testing facilities equipment
642.07	Steps basis of payment
643.06	Microwave detector added - magnetometer deleted
643.08	Wire conduits thickness
643.09	Service connections
643.17	Documentation for equipment
652.05	Traffic cones
652.09	Flagger training
703.07	Composition of mixture
703.09	Grading "D" mix design
712.03	Portland cement for concrete curb added
712.04	Stone curb dimensions added
712.05	Preformed plastic pavement markings
713.01	Structural steel specifications
713.02	Direct tension indicators added
717.01	Packed weight granular fertilizer
717.03	Seeding method number 3
718.01	Vehicular signal indications
718.05	Microwave detectors
718.07	Controllers
718.10	Program selection
719.01	Reflective sheeting
719.02	Demountable high intensity reflectorized letters
719.06	Demountable reflectorized delineators
719.07	Assembly hardware
720.05	High mast light standard weld
721.01	Breakaway devices

COMMON METRIC UNITS AND CONVERSIONS

Quantity	Multiply:	By:	To Get:
Length	mi	1.609 344	km
	ft	0.304 8	m
	in	25.4	mm
Area	sq. mi	2.590 0	km ²
	acre	0.404 856	ha
	sq. yd	0.836 127	m ²
	sq. ft	0.092 903	m ²
Volume	cu. yd	0.764 555	m ³
	cu. ft	0.028 317	m ³
	gal	3.785 41	L
Mass	lb	0.453 592	kg
	ton	0.907 184	Mg
Mass/unit area	psf	4.882 43	kg/m ²
Mass Density	pcf	16.018 5	kg/m ³
Force	lb	4.448 22	N
	kip	4.448 22	kN
Force/unit length	kdf	14.593 9	kN/m
Pressure, stress Modulus of elasticity	psf	47.880 3	Pa
	ksf	47.880 3	kPa
	psi	6.894 76	kPa
	ksi	6.894 76	MPa
Bending moment torque	ft-lb	1.355 82	Nm
Moment of force	ft-kip	1.355 82	kNm
Moment of inertia	in ⁴	416 231	mm ⁴
Section modulus	in ³	16 387.064	mm ³
Temperature	° F	5/9(° F-32)	° C

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DIVISION 100 -- GENERAL PROVISIONS

SECTION 101 -- DEFINITIONS AND TERMS

Wherever in these specifications, on the plans or in other contract documents the following terms are used, the intent and meaning shall be interpreted as follows:

101.01 Abbreviations. The following abbreviations are to be construed the same as the respective expressions represented:

AAN	American Association of Nurserymen, Incorporated
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
AREA	American Railway Engineering Association
ARTBA	American Road & Transportation Builders Association
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWPA	American Wood-Preservers Association
AWS	American Welding Society
EIA	Electronic Industries Association
FHWA	Federal Highway Administration
FSS	Federal Specifications and Standards, General Services Administration
IES	Illuminating Engineering Society
IMSA	International Municipal Signal Association
IPCEA	Insulated Power Cable Engineers Association
ISO	Insurance Services Office
ITE	Institute of Transportation Engineers
MDOT	Maine Department of Transportation
MRSA	Maine Revised Statutes Annotated
MUTCD	Manual On Uniform Traffic Control Devices
NBS	National Bureau of Standards
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NESC	National Electric Safety Code
SAE	Society of Automotive Engineers
SSPC	Steel Structures Painting Council
TAPPI	Technical Association of Pulp and Paper Industry
USDA	United States Department of Agriculture
UL	Underwriter's Laboratory

101.02 Acceptance Test. Test that determines the quality of the material at the time of incorporation in the work and includes control tests, certified tests and certificates of compliance.

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

furnished.

101.04 Aggregate. Inert material such as sand, gravel, broken stone or crushed stone or a combination thereof.

101.05 Award. The acceptance by the Department of a bid proposal.

101.06 Base Course. The layer or layers of specified or selected material of designated thickness placed on a subbase or a subgrade to support a surface course.

101.07 Bidder. An individual, firm, corporation, partnership, joint venture, sole proprietorship or any other entity submitting a proposal for the advertised work.

101.08 Bridge. A structure having a clear span of 3 m {10 feet} or more measured at the elevation of the bridge seats along the centerline of the road or in case of multiple spans when the combined clear spans equal or exceed 3 m {10 feet}.

- (a) Length. The length of a bridge structure is the overall length measured along the construction centerline 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.
- (b) 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 case of multiple height of curbs, between the bottoms of the lower risers.

101.09 Calendar Day. Each day shown on the calendar, including Sundays and Holidays.

101.10 Change Order. A written order issued by the Engineer to the Contractor, covering changes in the plans or quantities or both, within the scope of the contract and establishing the basis of payment and time adjustments for the work affected by the changes.

101.11 Commissioner. The Commissioner of Transportation established by 23 MRSA § 4203(1).

101.12 Conduit. A pipe used for receiving and protecting wires or cable.

101.13 Construction Limit Line. A line outside of the established right-of-way indicating the limits the work will be performed and within which the Contractor may work.

101.14 Construction Easement (Right-of-Way). A right acquired by public authority to use or control property, outside of the established right-of-way limits for a designated project.

101.15 Contract. A written agreement setting forth the

respective obligations of the Department and the Contractor for any project, any part thereof, or more than one project, which shall also be referred to herein as the contract documents.

The contract documents may include, but are not limited to, the advertisement, proposal, agreement, contract form, bid, performance, payment and other bonds, standard and supplemental specifications, special provisions, work drawings, shop drawings, contract assemblies, general and/or detailed plans, all required notices with respect to any of the foregoing, change orders, extra work orders, Resident's directives, plans, proposal guaranty, schedule of work, any supplementary agreement, and all other documents required hereunder to complete the construction of the work in a manner acceptable to the Department, including authorized extensions thereof, all of which constitute one instrument. The contract shall not be modified, altered or otherwise changed by any oral promise, statement or representation made either by the Department or Contractor after the execution of the contract, unless such modification, alteration or change is reduced to writing in accordance with the contract documents.

101.16 Contract Bonds. The form of security approved by the Department, executed by the Contractor and his Surety or Sureties, guaranteeing complete execution of the contract and all supplemental agreements thereto, and the payment of all obligations pertaining to the construction of the project.

101.161 Contract Proposal Bond. The security furnished by the Contractor and his Surety to guaranty the obligations of the Contractor pursuant to its proposal on any project or part thereof.

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

101.18 Contract Payment Bond. The security furnished by the Contractor and his Surety to guarantee payment of all obligations incurred by the Contractor on any project.

101.19 Contract Performance Bond. The security furnished by the Contractor and his surety to guarantee performance of the work in accordance with the contract documents.

101.20 Contract Time. The number of working days or calendar days allowed, or the specified completion date established for completion of the work, including all authorized extensions of time.

101.21 Contractor. The individual, firm, corporation, partnership, joint venture, sole proprietorship or any other entity contracting with the Department for performance of prescribed work. The contracting entity shall be an independent Contractor with respect to the Department and shall not be an employee, agent or representative of the Department.

101.22 Vacant

101.23 Culvert. Any structure not defined as a bridge which provides a drainage opening under the roadway or approaches to the roadway.

101.24 Department. The Department of Transportation of the State of Maine, as established by 23 MRSA § 4202 et seq for the administration of highway, bridge and other public works; acting through the Commissioner of Transportation or through his duly authorized representative.

101.25 Vacant

101.26 Drainage. The system of pipes, drainage ways, ditches and structures by which surface or subsurface waters are collected and conducted from the highway area.

101.27 Engineer. The Chief Engineer of the Maine Department of Transportation, acting directly or through his duly authorized representatives.

101.28 Equipment. All machinery, equipment, supplies for repair and maintenance thereof tools and other apparatus necessary for the proper construction and acceptable completion of the work.

101.29 Extra Work. An item of work or labor and materials to be furnished by the Contractor not provided for in the contract, but found essential for the satisfactory completion of the project.

101.30 Extra Work Order. A change order for the performance of work or furnishing of materials involving extra work. Extra work may be performed at agreed prices or on a force account basis as provided elsewhere in these specifications.

101.301 Force Account Work. Prescribed work paid on the basis of actual costs and appropriate additives.

101.31 Haul Road. A private way leading to a public way, used by the Contractor to provide materials to be incorporated in the work or to remove surplus material not required for the work.

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

101.33 Inspector. An authorized representative of the Resident assigned to make detailed inspections of the work to determine compliance with the contract.

101.34 Vacant

101.35 Laboratory. The testing laboratory of the Department or its designee.

101.36 Lane. A strip of traveled way intended to accommodate the forward movement of a single line of vehicles.

101.37 Holidays. Holidays shall include the following days: New Year's Day, Martin Luther King Day, Washington's Birthday, Patriot's Day, Memorial Day, Independence Day, Labor Day, Columbus Day, Veterans Day, Thanksgiving Day and Christmas Day. If any holiday listed above occurs on a Sunday the following Monday shall be considered a holiday.

101.38 Lines of Improvement. Irregular lines, left and right of the roadway centerline, within which construction will be performed.

101.39 Liquidated Damages. An amount due and payable to the Department by the Contractor for additional costs incurred by the Department resulting from Contractor's failure to comply with Section 108.08

101.40 Supplemental Liquidated Damages. An amount due and payable to the Department by the Contractor for additional damage resulting from his failure to complete specific work within a specified date or time. These supplemental liquidated damages are in addition to and separate and distinct from Liquidated Damages as set forth in Section 101.39.

101.41 Lump Sum. The single price bid by a Contractor as a single amount for a complete contract item as defined by the specifications.

101.42 Materials. Any substances specified for use in the construction of the project and its approaches.

101.43 Notice of Award. A written notice to the selected bidder stating that the bid proposal has been accepted by the Department and that the selected bidder is required to execute the Contract Agreement and furnish Performance and Payment bonds satisfactory to the Department.

101.44 Notice to Contractors. The official notice stating the time and place for the submission of bid proposals.

101.45 Notice to Commence Work. Written notice to the Contractor to proceed with the contract work including, when applicable, the date of beginning of contract time.

101.46 Owner. The legal or record owner of the building or premises on which the contract work is to be performed.

101.47 Pavement Structure. The combination of subbase, base course and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.

101.48 Plans. The approved plans, profile, typical cross sections, working drawings, and supplemental drawings or exact reproductions thereof, which show the location, character, dimensions, and details of the work to be done.

101.49 Premises. Land of the owner on which the building or buildings now stand or to which they are to be moved.

101.50 Process Control Test. Test performed by the Engineer at the source of supply to determine the capability of the material prior to delivery.

101.51 Profile Grade. The trace of a vertical plane intersecting the top of the wearing surface, usually along the longitudinal centerline of the roadbed. Profile grade means either elevation or gradient of such trace according to the context.

101.52 Project. The specific section of the highway or bridge or both, together with all appurtenances and construction to be performed thereon under the contract.

101.53 Proposal. The offer of a bidder on a form prescribed by the Department, to perform the work and to furnish the labor and materials at the prices quoted.

101.54 Vacant

101.55 Proposal Guaranty. The security designated in the proposal and furnished with a bid to guarantee that the bidder will enter into the contract if his bid is accepted.

101.56 Questionnaire. The specified forms on which the Contractor shall furnish required information as to his ability to perform and finance the work.

101.57 Reference Stake. Stake set beyond the line of improvement for use as control for the new construction.

101.58 Resident Engineer. A Registered Professional Engineer project representative of the Chief Engineer acting within the scope of the duties assigned to him or the authority given him.

101.59 Resident Inspector. A person, other than a Registered Professional Engineer, who is assigned as a project representative of the Chief Engineer in the same capacity and with the same duties and authority as a Resident Engineer.

101.60 Right-of-Way. A general term denoting land, property

or interest therein, usually in a strip, acquired for or devoted to a highway.

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

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

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

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

101.65 Roadway. The portion of a highway, including shoulders, for vehicular use. A divided highway has two or more roadways.

101.655 Schedule of Items. The list of contract work items in the rear of the Proposal Book on which bidders submit their bid prices.

101.66 Schedule of Work. The approved work schedule submitted by the Contractor containing dates of commencement and completion of various work items within the contract time.

101.67 Section. (When referring to the Specifications). A numbered article or group of related articles forming a part of the specifications and applying to or controlling the procedure of an operation or regulation.

101.68 Shoulder. The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use and for lateral support of base and surface courses.

101.69 Sidewalk. That portion of the roadway primarily constructed for the use of pedestrians.

101.70 Skew or Skew Angle. The acute angle formed by the intersection of the line normal to the centerline of the roadway or the working line of the superstructure with a line parallel to the face of the substructure or in the case of structural plate units and culverts, with the centerline of the structural plate units and culverts.

101.71 Specialty Items. Specialty Items shall be limited to

work that requires highly specialized knowledge, craftsmanship or equipment not ordinarily available in contracting organizations qualified to bid on the contract as a whole and in general are to be limited to minor components of the overall contract.

101.72 Special Provisions. Additions and revisions to the Standard Specifications and Supplemental Specifications covering specific conditions an on individual project.

101.73 Specified Completion Date. The date in the contract on which the contract work shall be complete.

101.74 Specifications. A general term applied to all directions, provisions and requirements pertaining to material and performances of the work.

101.75 State. The State of Maine acting through its authorized representatives.

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

101.77 Structures. Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, endwalls, buildings, sewers, services pipes, underdrains, foundation drains and other features which may be encountered in the work and not otherwise classed herein.

101.78 Subbase Course. The layer or layers of specified or selected material of designated thickness placed on the subgrade to support a base course or a surface course.

101.79 Subcontractor. An individual, firm, corporation, partnership, joint venture, sole proprietorship or any other entity to whom the Contractor sublets parts of the project.

101.80 Subgrade. The top surface of a roadbed upon which the pavement structure and shoulders are constructed.

101.81 Substructure. All of that part of the structure below the bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, together with the backwalls, parapets and wing walls of abutments.

101.82 Superintendent. The Contractor's authorized on site representative in charge of and responsible for the work.

101.83 Superstructure. All that part of the structure above the bearings of simple and continuous spans, skewbacks of arches and top of footings of rigid frames, excluding backwalls, wingwalls and wing protection railing.

101.84 Supplemental Specifications. Additions and revisions to these Standard Specifications that are adopted subsequent to

issuance of the printed book of Standard Specifications.

101.85 Supplementary Agreement. A written agreement executed by the Contractor and the Department for the furnishing of materials or the performance of work not included in the original contract which is necessary for the proper completion of the work.

101.86 Surety. The corporation, company, partnership or individual, other than the Contractor, executing a bond furnished by the Contractor.

101.87 Surface Course. One or more layers of pavement designed to accommodate the traffic load. The top layer may be called the Wearing Course.

101.88 Titles and Headings. The titles and headings of the Sections and Subsections herein are intended for convenience of reference and shall not be considered as having any bearing on the content and interpretation thereof.

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

101.90 Traveled way. The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

101.91 Unit Price. The price bid by the Contractor for one unit of work, as defined by the specifications.

101.92 Utility. An entity subject to the jurisdiction, control and regulation of the Maine Public Utilities Commission and as further defined in 35 M.R.S.A. Sec. 15(13). For the purposes of this definition providers of rail service are considered utilities unless otherwise indicated herein.

101.93 Work. Work shall mean the furnishing of all labor, materials, equipment, supplies, services, personnel, and other incidentals necessary for the completion of the project in accordance with the contract.

101.94 Working day. A calendar day, exclusive of Saturdays, Sundays, holidays and the period from November 15th to May 15th, inclusive on which weather and other conditions not under the control of the Contractor will permit construction operation to proceed for 70 percent of the hours of the usual working day with normal working force.

Saturday shall be considered one half of a working day if the Contractor works 2 or more hours during the forenoon. If the Contractor works after 12 o'clock noon, it shall be considered as one working day. If after approval, work is performed on a Sunday or Holiday, the day shall be considered a working day. Work necessary either for the safety of the traveling public or maintenance performed on Sundays or Holidays which is neither

caused by nor resulting from any fault of the Contractor will not be considered a working day.

101.95 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 for approval.

101.96 Work Order. A written directive, signed by the Engineer, directing the Contractor to perform work or comply with any obligation as set forth in the contract documents.

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

SECTION 102 -- BIDDING REQUIREMENTS AND CONDITIONS

102.01 Qualification of Bidders. When an apparent low bidder has not been awarded a contract by the Department within the past five years of the date of opening proposals, that bidder will be required to fill out and submit a "Questionnaire and Financial Statement for Bidders" before consideration will be given to award this contract. The completed report must be submitted within 10 days after the date of opening of proposals.

The executed form shall include a complete report of the bidder's financial resources and liabilities, equipment, past record and personnel.

102.02 Notice to Contractors. The Notice to Contractors will contain a description of the proposed work, instructions to the bidder regarding the contract documents and the reservation of the right of the Department to reject any or all proposals.

102.03 Method of Obtaining Plans, Specifications and Proposal Forms. Plans, specifications and proposal forms may be seen and obtained at the office of the Maine Department of Transportation,

Augusta, Maine, upon payment as specified in the Notice to Contractors.

102.04 Contents of Proposal Forms. The proposal form will state the location and description of the contemplated construction and will show the estimate of the various quantities and kinds of work to be performed or materials to be furnished and will have a Schedule of Items for which unit or lump sum bid

prices are invited. The proposal form will state the time in which the work must be completed, the amount of the proposal guaranty and the date, time and place of the opening of proposals. The proposal form will also include special provisions or requirements which vary from or are not contained in the Standard Specifications.

All papers bound with or attached to the proposal form 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 form will be considered a part of the proposal whether attached or not.

The prospective bidder will be required to purchase from the Department each copy of the proposal form and each set of plans. The purchase price will be stated in the Notice to Contractors.

When there is more than one item for payment, specified under the same contract pay item, another digit or digits will be added to the end of the decimal of the pay item number to differentiate between the various pay items. The item number shown in these specifications for this particular case will not be used directly but will be altered as shown in the following illustration:

Item number shown in these specifications = 900.06

Pay item number for use in the proposal = 900.061, 900.062,- etc.

102.05 Issuance of Proposals. The Department may disqualify or refuse to issue a proposal if the Department determines that a bidder is in default for any of the following reasons:

- (a) Inadequate machinery, personnel, plant, other equipment, or incompetency as revealed in any submission by the Contractor for any project or as a result of any other contract between the Department and Contractor as may be determined 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 obligations due for labor, material or services on former or current but uncompleted contracts in force at the time of issuance of proposals.
- (d) Failure to comply with all directives and regulations of the Department.

(e) Default under previous contracts.

102.06 Quantities in the Schedule of Items. The quantities appearing in the Schedule of Items are approximate and are to be utilized for bid comparison only. The quantities furnished in the Schedule of Items shall be provided without liability on the part of the Department and the Department neither guarantees nor warrants that these quantities shall be the actual amounts used on any project or portion thereof. The Department reserves the right to increase or decrease the estimated quantities shown or to omit items. Payment to the Contractor will be made only for the actual quantities of work performed and accepted or materials furnished in accordance with the contract.

102.07 Examination of Contract Documents and Site of Work. The Department will prepare plans and specifications for the performance of work on the project. The bidder is expected to carefully examine the site of the proposed work and all available contract documents before submitting a proposal. The submission of a bid shall be considered prima facie evidence that the bidder has made such examination and is satisfied as to the conditions to be encountered in performing in the work and as to the requirements of the contract documents. The bidder will be held responsible for his failure or neglect to observe or comply with these instructions.

The bidder shall have access to and may examine, at the office of the Department, the record of all borings, test excavations, other subsurface investigations and soil analyses, if any, made for design purposes prior to the construction of the project, the records of which may or may not be shown on the plans. Any subsurface information available is based on investigations made at the specified location indicated. The Department makes no guaranties, representations or warranties, either expressed or implied, with respect to any such information, and further cautions the bidder that these conditions are not necessarily typical and that they may have changed since the field data was obtained. The Department further makes no guaranties, representations or warranties, either express or implied, that the presence or absence of water on the site and any subsurface explorations when made, will be representative of actual conditions at the time of construction. It is the obligation of the bidder to ascertain subsurface site conditions from his own investigations prior to submitting a proposal. The selected bidder agrees, in executing this contract, that he waives any and all claims and causes of action against the Department if in carrying out the work he finds that the

actual conditions encountered do not conform to those conditions shown by any subsurface investigations or analyses.

102.08 Preparation of Proposal. The bidder shall submit his proposal upon the forms furnished by the Department. The bidder shall specify a unit price or lump sum price, legibly written in numerals for each pay item for which a quantity is given and shall also show the products of the respective unit prices and 1-24ities legibly written in numerals in the column provided and the total amount of the proposal obtained by adding the amounts of several items. All numerals shall be in ink.

When an item in the proposal contains a choice to be made by the bidder, the bidder shall indicate his choice in accordance with the specifications for that particular item and thereafter no further choice will be permitted.

If a unit price or lump sum bid already entered by the bidder in the proposal is to be altered it shall be crossed out with ink and the new price entered above or below and initialed by the bidder, also with ink. This new price shall be the controlling price.

The bidder's proposal must be correctly signed with ink by the individual, or by one or more members of the partnership, or 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 and acceptable to the Department. If the proposal is made by an individual or sole proprietorship, the bidders name and post office address must be shown; by a partnership, the name and post office address of each partnership member must be shown; by a joint venture, the name and post office 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 officials must be shown.

In addition, an affidavit executed and sworn to must accompany each proposal submitted by a corporation indicating the authority of the designated official to sign each document on behalf of the corporation.

102.09 Irregular Proposals. Proposals will be considered irregular and may be rejected for 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.

- (b) If there are unauthorized additions, conditional or alternate bids or irregularities of any kind which 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 for each pay item listed unless otherwise specified.
- (e) If any of the bid prices are unbalanced.
- (f) If the proposal lacks any of the requirements of Subsection 102.08.

102.10 Proposal Guaranty. No proposal will be considered unless accompanied by a guaranty in an amount not less than the amount indicated in the proposal form and made payable to the Treasurer of the State of Maine. Acceptable forms of guaranty are a satisfactory bid bond, a cashier's check, a certified check, a negotiable certificate of deposit or a United States Postal money order. A bidder using a certificate of deposit for a proposal guaranty must have the certificate form approved by the Department of Transportation prior to the submission of the bid.

If a bond is used it shall be prepared on the Department's prescribed form and shall be procured from an insurance company or bonding company satisfactory to the Department and licensed to do surety bond business in the State of Maine.

102.11 Delivery of Proposals. Each proposal shall be submitted in a sealed envelope. The envelope shall be correctly labeled to indicate the contents. When an envelope other than one furnished by the Department is used, it shall be of the same general size and shape and be similarly labeled to indicate the contents. Proposals shall be filed prior to the time and at the place specified in the Notice to Contractors. Proposals received after the time for opening of bids will be returned to the bidder unopened.

102.12 Withdrawal or Revision of Proposals. A bidder may withdraw or revise a proposal after it has been deposited with the Department, provided the request for such withdrawal or revision is received by the Commissioner or Chief Engineer, in writing or in person, before the time set for opening proposals.

In addition to the above, any bidder who has submitted proposals on more than one project may, by a request in writing or in person, withdraw any or all of his additional proposals after the Department or its representative has announced that such bidder has submitted the apparent lowest proposal on the

project for which bids have last been read. When this option is exercised, the proposal for any other project will be returned to the bidder unopened, provided the request for the withdrawal of the other proposal is made before the total amount of the first bid for any other project for which he has submitted a bid is read. No returned proposals will be considered after the bidder exercises his privilege to withdraw. A bidder exercising the privilege to withdraw any bid hereunder waives any and all claims against the Department that may arise in the event his opened proposal is not in proper form or for any other reason is unacceptable to and rejected by the Department.

102.13 Combination Proposals. Proposals may be issued for projects in combination or separately, so that bids may be submitted either on the combination or on separate units of the 1-26e combination. The Department reserves the right to make awards on combination bids or separate bids to the best advantage of the Department. No combination bids, other than those specifically set up in the proposals by the Department will be considered.

102.14 Public Opening of Proposals. Proposals will be opened by the Department Representative in the order in which they are drawn and read publicly at the time and place indicated in the Notice to Contractors. Bidders, their authorized agents and other interested parties are invited to be present.

102.15 Disqualification of Bidders. Any of the following shall be sufficient for the disqualification of a bidder and the rejection of his proposals:

- (a) More than one proposal for the same work from an individual, sole proprietorship, partnership, joint venture, firm or corporation under the same or with the same principals.
- (b) Any evidence of collusion among bidders.
- (c) Failure to file with the Department the requisite affidavits regarding collusion and restraint of free competitive bidding as required by the Department and the United States Secretary of Transportation under Title 23 of the United States Code.
- (d) Lack of competency, as determined by the Department.
- (e) Lack of responsibility in past work for the Department with respect to any aspect thereof, including but not limited to workmanship and progress on any project.
- (f) Incomplete work which, in the discretion of the Department might hinder or prevent the prompt completion of additional work if awarded.

(g) Any arrearages which remain on existing or previous contracts, or having defaulted on a previous contract.

102.16 Material Guaranty. Before a contract is awarded, the successful bidder may be required 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, together with samples which may be subjected to the tests herein provided to determine their quality and fitness for the contract.

102.17 Non-resident Contractors. The successful bidder, if a foreign corporation, firm, individual, sole proprietorship, joint venture, partnership, or other entity, shall file, with the Department at the time of the execution of the contract documents, a written appointment of a resident attorney of the State of Maine having an office or place of business within the State, to be his

1-27his true and lawful attorney upon whom all lawful processes in any actions or proceedings against him may be served. The appointment shall set forth the attorney's place of residence and shall include a provision that the Contractor shall agree that any lawful process against him which is served on said attorney shall be of the same legal force and validity as if served on him personally or upon his firm, sole proprietorship, corporation, joint venture, partnership or other entity and that authority shall continue in force as long as any potential liability remains outstanding against him in this State as a result of work performed on any project for the Department. The appointment shall be filed in the office of the Secretary of State. Service of such process shall be made by leaving a copy of the process in the hands or in the office of the resident attorney and Contractor hereby expressly agrees that such service shall be effective upon the Contractor, as if service were made in accordance with Rule 4 of the Maine Rule of Civil Procedure, and further expressly waives any and all defenses regarding service of process under Rule 12 of said Civil Rules or otherwise. The appointment shall continue in force until revoked by a written instrument. Contractor may thereafter designate some other person upon whom such process may be served which instrument shall be filed in the manner provided herein for the original appointment.

A Non-resident Contractor shall be one or more of the following:

- (a) Any person who is not a resident of the State of Maine.
- (b) Any firm, corporation, partnership, joint venture, sole proprietorship or other entity which is not a Maine

corporation licensed to do business within the State of Maine, or has a principal place of business within the State of Maine.

SECTIONS 103 -- AWARD AND EXECUTION OF CONTRACT

103.01 Consideration of Proposals. After the proposals are opened and read, they will be compared by the Department on the basis of the summation of the products of the approximate quantities shown in the Schedule of Items and the unit bid prices. The results of such comparisons will be available to the public. In the event of a discrepancy between unit bid prices and extensions, the unit bid price shall govern.

When unit bid prices indicate a credit to the State, the net result will be that result obtained by subtraction of the totals of the credit item or items from total of the plus item or items in the Schedule of Items. Double spaces will be provided in the Schedule of Items for those items which it is anticipated that a credit or minus unit price might be entered. This does not prohibit credit or minus bidding on items for which no double

1-28spaces are provided in the schedule. However, care must be exercised to write the word "CREDIT" in conjunction with the amount shown under the column headed Items and Unit Prices Bid, otherwise a plus unit price will prevail. The possibility of the withdrawal, by the Department, at some future date of a credit or minus item from the contract will not be a factor in the determination of the low bidder.

The Department reserves the right to reject any or all proposals, to waive technicalities or to advertise for new proposals, if the best interests of the Department will be promoted.

103.02 Award of Contract. The award of contract, if it be awarded, will be made within thirty calendar days after the opening of proposals, to the lowest responsible bidder whose proposal complies with all the requirements specified and provides assurance for utilization of disadvantaged businesses as determined by a compliance review to be conducted prior to award. Award will not be made to a bidder who cannot show such assurance. The successful bidder will be notified by registered or certified letter mailed to the address shown on his proposal, that his bid has been accepted and that he has been awarded the contract.

103.03 Cancellation of Award. The Department reserves the right to cancel the award of any contract at any time before the execution of said contract by all parties without any liability against the Department.

103.04 Return of Proposal Guaranty. All proposal guaranty checks, except those of the 2 lowest bidders, will be returned within 3 days following the opening and verifying of proposals. The proposal guaranty check of the unsuccessful of the 2 lowest bidders will be held until the contract is executed by the successful bidder, at which time this proposal guaranty check will be returned. The proposal guaranty check of the successful bidder will be retained until after the contract has been executed after which it will be returned.

If all proposals are rejected all guaranty checks will be returned within 3 days of the date of rejection. Unopened or informal proposals which are rejected will be returned as soon as practicable.

Proposal guaranty bid bonds will not be returned unless requested.

103.05 Performance and Payment Bonds. The successful bidder must furnish the following bonds within the time provided for execution of the contract agreement:

- (a) A Contract Performance Bond for an amount equal to the full amount of the contract for the prompt and faithful performance and completion of the work to be done under

30e contract.

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- (b) A Contract Payment Bond for an amount equal to the full amount of the contract for the payment in full for all labor and material used or required in connection with the work set forth by the contract.

The two bonds shall be payable to the Treasurer of the State of Maine. The forms of the bonds shall be those provided by the Department and the surety shall be acceptable to the Department. Each bond shall be procured from United States insurance or bonding companies licensed to do surety bond business in the State of Maine.

For contracts in the amount of \$50,000 and less, certified checks payable to the Treasurer of the State of Maine or other negotiable security acceptable to the Department may be deposited with the Treasurer of the State of Maine in place of surety company bonds and shall be subject to all conditions of such bonds and to such agreements as may be required by the Department.

In the event any claim arises with respect to any obligations covered by these bonds, the applicable surety company must provide any claimant, including the Department, with full payment of the entire claim within 60 days of written notice or receipt thereof. In the event all or part of the claim is disputed or contested by the surety company, said company shall provide written notice within said 60 day period of all basis upon which it is denying or contesting payment. Failure of the surety company to provide such notice shall constitute acknowledgment that the claim brought against the Contractor for which payment is demanded against the surety is valid and undisputed.

103.06 Execution and Approval of Contract. The selected bidder shall sign the contract agreement within 15 calendar days after the date of the Notice of Award and shall return all executed and required contract documents to the Department in Augusta, Maine within said period. In the event said 15th day falls on a holiday, Saturday or Sunday, Contractor shall be considered in compliance with this Subsection provided all executed and required contract documents are received on the next Departmental business day thereafter. The Department may execute the contract agreement within 30 days of the date of the Notice of Award, but in no event prior to such execution by the Contractor. In the event the Department fails to execute the contract agreement within the required 30 days, the selected bidder shall have the right to withdraw the proposal without loss of the proposal guaranty. All contracts shall be considered effective upon execution by all parties thereto. Three counterpart originals of the contract agreement shall be

executed, one to be kept by the Department, the second to be delivered by the Department to the State Controller and the third to be returned to the Contractor. The Contractor may request in writing and the Department may provide for an extension of time for execution of the contract agreement by the Contractor for good cause shown and provided said

1-32said extension is in the best of the Department.

103.07 Failure to Execute Contract. Failure of the selected bidder to execute and provide all requisite contract documents at the times stated in the proposal shall be just cause for the cancellation of the award and the forfeiture of the proposal guaranty which shall become the property of the State. The Department may then award the contract to the next lowest responsible bidder if such award would be in the best interest of the Department. Alternatively, the work may be readvertised and constructed under contract or otherwise, as may be in the best interest of the Department. Any bidder failing to execute any contract under this Subsection shall be prohibited from submitting a new proposal for the same work in the event that work is readvertised. If any responsible bidder refuses to accept an award, the Department may refuse to consider any proposal of the bidder for a period of 3 years from the date of such refusal.

103.08 Insurance. Before work is commenced pursuant to the Agreement, the Contractor shall file with the Department a Certificate of Insurance, executed by an insurance company or companies satisfactory to the Department and licensed or approved by the State of Maine Department of Business Regulation, Bureau of Insurance to do business in the State of Maine, stating that the Contractor carries insurance in accordance with the following requirements and stipulations:

- (a) Workers' Compensation Insurance. With respect to all operations performed by the Contractor and any subcontractors, the Contractor or each subcontractor shall carry Workers' Compensation Insurance or shall qualify as a self-insurer with the State of Maine Workers' Compensation Commission, all in accordance with the requirements of the laws of the State of Maine. Where maritime exposures exist, coverage should be arranged to include United States Long Shore and Harbor Workers coverage.
- (b) Commercial General Liability. With respect to all operations performed by the Contractor and any subcontractors, the Contractor and any subcontractors, shall carry commercial general liability or other

coverage affording equal or greater protection as determined by the Department, in an amount not less than \$1,000,000 per occurrence and \$2,000,000 in the aggregate. Such policy shall include products and completed operations as well as contractual liability coverages, and must include ISO form Number CG25031185 or equivalent.

The contractual liability insurance shall cover the liability assumed by the Contractor under the contract documents to indemnify, defend and hold harmless

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34he Department and its agents,

representatives, officers and employees, with respect to any and all claims, causes of action, losses, expenses or damages resulting in death, bodily injury or property damage.

Where the work to be performed entails the use of barges, tug boats, work boats, supply boats, etc., Protection and Indemnity coverage shall be provided at the limits called for under Commercial General Liability insurance.

Where the work to be performed has to do with railroads, then railroad protective liability insurance shall be provided, with the Maine Department of Transportation as a named insured.

- (c) Automobile Liability Insurance. The Contractor shall carry Automobile Liability Insurance covering the operation of all motor vehicles, special mobile equipment including any which are rented, leased, borrowed or otherwise used in connection with the project. The limit of liability under this section shall be \$1,000,000 per occurrence.
- (d) Professional Liability Insurance. Contractors who engage in design work, preliminary engineering work and environmental consulting work for the Department shall maintain a Professional Liability policy for errors and omissions with a minimum limit of liability of \$250,000. The Department reserves the right to require increased insurance limits for certain major projects. This policy shall cover "wrongful acts" as defined; wrongful act means a negligent act, error or omission by the Contractor, or any entity for whom the Contractor is legally liable, arising out of the performance of, or failure to perform, professional services. This wording, or similar, is required of this insurance.
- (e) Builders Risk Insurance. The Contractor shall provide Builders Risk Insurance if the project requires it. This determination will be made by the Department and shall be so stated in the Special Provisions.
- (f) Blasting. When explosives are to be used in the prosecution of the work, the Contractor shall carry insurance, in the amount of \$1,000,000 per occurrence, for protection against damage claims due to such use of explosives.
- (g) Execution and Limitation. Each policy shall be signed by the President and Secretary of the insurance company and shall be countersigned by a licensed resident agent of the State of Maine as an authorized representative of the company. Each policy with the exception of Workers'

Compensation and Professional Liability insurance shall name the Department of Transportation as an additional insured.

- (h) Claims. Each insurance policy shall include a provision requiring the carrier to investigate and defend all named insurers against any and all claims for death, bodily injury or property damage, even if groundless.
- (i) Compliance. The Contractor shall be in compliance with this Section provided he procures either one policy of insurance covering all work under the contract or separate insurance policies for all segments constituting the entire project. In either case a Certificate of Insurance must be filed for each policy indicating that all required insurance has been obtained.

SECTION 104 -- SCOPE OF WORK

104.01 Intent of Contract Documents. The intent of the contract documents is to provide for the construction and completion of the work described to the satisfaction of the Department. The Contractor shall furnish all labor, materials, equipment, tools, transportation services and supplies required to complete the work in accordance with the contract documents.

104.02 Alteration of Plans or Character of Work. The Department may increase or decrease any quantities or alter any details of construction contained in the contract documents at any time. Any increase, decrease or alteration hereunder shall be covered by all contract bonds and insurance policies required under the contract documents and shall be considered as if a part of the original contract.

Under no circumstances shall alterations of plans or of the nature of the work involve work beyond the termini of the proposed construction except as may be necessary to satisfactorily complete the project.

In the event such increase, decrease or alteration substantially changes either the character of the work to be performed or the cost thereof, an increase in either the contract time or contract price or both shall be provided in writing to the Contractor, either in amounts agreed to between the parties or, provided no agreement can be made, in an amount determined by the Department to be in its best interest.

No claim shall be made by the Contractor for loss of anticipated profits because of alterations or by reason of any

variation between the approximate quantities and the final quantities of work done.

Payment for work changes or alterations will be made in accordance with the provisions set forth under Subsection 109.03. If the altered work increases the total cost of the work performed, an increase in contract time will be computed in accordance with the provisions of Subsection 108.06.

104.03 Extra Work. The Contractor shall perform extra work for which there is no price included in the contract documents whenever it is in the best interest of the Department to complete the work. Before any extra work is started, a written supplemental agreement shall be executed between the Contractor and the Department which shall become a part of, and the work thereunder paid for in accordance with, the contract documents. In the alternative, the Department may require the Contractor to do extra work on a Force Account basis. Such work shall be performed in accordance with these Standard Specifications and as directed by the Department and will be paid for as provided under Subsection 109.04.

104.04 Maintenance of Traffic. While under construction, the roadway shall be kept open to traffic unless otherwise provided.

The Contractor shall keep that portion of the project being used for public travel, whether it be used by through or local traffic and whether it is on new or old location of the road between project termini, in a condition that traffic will travel over a satisfactory surface at all times with a minimum of delay. Portions of the project open to public traffic shall have a minimum width as specified in Section 652 -- Maintenance of Traffic.

The Engineer may authorize and pay for granular materials capable of supporting traffic and necessary to maintain the specified traffic lane widths providing the following conditions are complied with:

- (a) The location where the granular materials are to be used shall be prepared by eliminating objectionable material and providing adequate temporary drainage before the granular material is placed.
- (b) Quantities of granular materials will be determined by the most appropriate method of measurement at the time the material is placed in accordance with the specifications for the particular type of granular material authorized for use.

- (c) Payment for granular material will be made at the contract unit price for the material authorized for use; Aggregate Base, Aggregate Subbase, Granular Borrow, Gravel Borrow, granular Common Excavation, granular Unclassified Excavation or granular Common Borrow, whichever is less, when the material is placed on the project.
- (d) Payment as Common Excavation will be made when material for maintenance of traffic is removed.

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. The Contractor shall bear all expenses in maintaining traffic over the section of road under construction whether it is on new or old location between project termini and of constructing and maintaining approaches, crossings, intersections and other features necessary, without direct compensation, except as authorized above or provided in Section 652 -- Maintenance of Traffic.

104.041 Special Detours. When the contract contains the item, Special Detours, the payment of such item shall cover all costs for constructing, repairing, maintaining and removing the detour or detours, including all temporary bridges and accessory features and obliteration of the detour road. Right-of-way for temporary detours or bridges or both called for under this paragraph, will be furnished by the Department unless otherwise indicated on the plans or stated in the Special Provisions.

104.042 and 104.043 Vacant

104.044 Maintenance During Suspension of Work. Prior to suspension of work the Contractor shall make passable and shall open to traffic those portions of the project under improvement, agreed upon by the Contractor and the Engineer for the temporary accommodation of traffic for the anticipated period of suspension. All portions of the project to be used by traffic during periods of suspension shall have a minimum width specified in Section 652 -- Maintenance of Traffic. To provide space for snow removal, this width shall be a minimum of 12 m {40 feet} in cuts.

Those portions of the existing highway to be used by traffic, between the termini of the project, on which the existing pavement has not been disturbed and on which the Contractor does not work, exclusive of cross culvert installations, clearing and

cutting trees and on which the Contractor does not haul excavation or other materials, may be approved for suspension if requested in writing by the Contractor. The pavement on those suspended portions will be maintained by the State until the Contractor commences or resumes work on them.

During periods of approved suspension of work, the Contractor will not be responsible for plowing snow, sanding ice, maintaining the road, patching or retreating the surface, repairing or replacing damaged guardrail, barricades, curbs, poles, signs, catch basins and other permanently installed items of the project.

Upon resuming work, following approved suspension, the Contractor shall clean up all evidence of snow and ice control including removing excess sand and debris from the roadway and replace all base or subbase material lost as a result of maintenance activity. No payment will be made for such work as it
1-39 it will be considered
included in the work of the contract.

104.045 Maintenance During Winter Construction. When the work is being performed during periods subject to winter weather conditions, the Contractor shall plow snow from the traffic lanes within the area of the project where the Contractor is performing work, including all bridges and sidewalks of bridges. All plowing required hereunder shall be performed at all times and days upon which such weather occurs. The Contractor shall plow snow from all traffic lanes, bridges or sidewalks. Any assignment or transfer of the responsibility of the Contractor under this Subsection shall be evidenced in writing by change order. Sanding of such traffic lanes, bridges or sidewalks will be performed by the governmental agency, whether state or municipal, which has jurisdiction over such facilities.

On portions of a project carrying traffic, including bridges, where no construction operations have taken place and on portions of a project where the Contractor has completed his operations leaving the roadway in a suitable condition to carry traffic, the State or other agency responsible for the winter maintenance will plow snow and sand.

104.05 Rights in and Use of Materials Found on the Work. The Contractor, with approval, may use on the project such stone, gravel, sand or other material found in the excavation and will be paid both for the excavation of such materials at the corresponding contract unit price and for the pay item for which the excavated material is used. Except for stone used for riprap, stone ditch protection and loam, the Contractor shall replace

with other acceptable material at his own expense, that portion of the excavated material so removed and used which was needed for use in embankment, backfill, approaches and otherwise. Stones and loam found in the excavation which are used for riprap, loam or loam stockpiled will not be required to be replaced with other material. No charge for any of the foregoing materials so used will be made against the Contractor. The Contractor shall not excavate nor remove any material from within the right-of-way which is not within the limits of improvement, without authorization.

104.06 Repair of Roads Damaged by Contractor. Damage to any road or structure caused by equipment, including trucks, used in the prosecution of the work shall be repaired to the satisfaction of the Department and the municipality affected by and at the expense of the Contractor. Except as otherwise provided in the contract documents, the Contractor shall not receive additional compensation for this repair work. The Contractor shall not be responsible for repair when such damage is caused by its trucks carrying legal loads and operating in full accordance with the laws of the State on either roads having a surface width of 6 m {20 feet} and over structures maintained by the Department.

In the event it is necessary for the Contractor to transport

gravel, borrow or other construction material in legally registered vehicles carrying legal loads over town ways, a Contractor's Bond for each kilometer {mile} of traveled length may be required by the town or other agency, the exact amount of the bond to be determined prior to use of any town way. The town may also require the Contractor to control dust. The Contractor will not be paid directly for any necessary bond, maintenance or dust control on town ways. Such costs shall be incidental to the contract.

Should the Contractor's operations create a dust nuisance on haul roads to private property, the Department will be responsible for the abatement of the dust nuisance. The Contractor will be compensated for dust control in accordance with contract items but other maintenance of such roads will be the responsibility of the Contractor.

The Contractor may haul in one direction only on roads having a bituminous surface width of less than 6.0 m {20 feet} and where an alternate route over wider roads is provided for the return trip. If no alternate route is available the Contractor shall be responsible for maintaining an acceptable road surface for a minimum width equal to the original pavement width.

104.07 Removal and Disposal of Structures and Obstruction. Unless otherwise provided, guardrail, drainage pipe, culverts, curbing, bridges or other manufactured highway material, except utility property, traffic control devices, lights and their supporting structures, found within the limits of the work, shall become the property of the Contractor. The material shall be removed as indicated by the grading limits and disposed of by the Contractor at no additional expense to the State except as hereafter provided.

Removal and disposal of highway material found above ground, such as guardrail, curbing and bridge steel, shall, unless otherwise provided, be considered included in the work of the contract and no separate payment will be made.

104.08 Final Cleaning up. Before final acceptance, the highway, bridges, streams, structures, lawns, property adjacent to the project and grounds occupied by the Contractor in connection with the work shall be cleaned of all rubbish, excess material, temporary structures and equipment and the ground graded to match the surrounding terrain and seeded and mulched if required. All parts of the work shall be left in an acceptable condition.

SECTION 105 -- CONTROL OF WORK

105.01 Authority of the Engineer. The Engineer will determine all questions which relate to the quality and acceptability of materials furnished, work performed, the rate of progress of the work, and questions of interpretation of the plans and

specifications which are in the best interest of the Department. This authority shall be in addition to any other authority of the Engineer as set forth in the contract documents.

105.02 Plans and Working Drawings. Plans showing the details of the construction contemplated will be furnished by the Department. Roadway plans may show alignment, profile grade, typical cross sections of improvements, right of way and general cross sections. Structure plans will show general features and design details of the structures unless otherwise specified.

The Department's plans shall be supplemented by the Contractor by such working drawings as are necessary to satisfactorily complete the work. Working drawings for structures shall consist of details required to satisfactorily complete the work that are not included in the plans furnished by the Department. Working drawings must be approved by the Engineer. Such approval shall not relieve the Contractor of any responsibility under the contract for the successful completion of the work.

At the Contractor's risk, the Department will allow preliminary work (e.g. Cutting materials to length) to be performed prior to the approval of the working drawings for the material concerned. No final assembly or fabrication of structural units will be allowed prior to final approval of the working drawings for the units concerned. The Contractor's Schedule of Work shall allow a sufficient period of time, prior to the start of production of the structural units, for the working drawing approval process as follows:

First Submission: 15 Working days or 1 working day/drawing, whichever is greater.

Second Submission: 10 Working days or 1/2 working day/drawing, whichever is greater.

When requested by the Contractor, the Department may allow production to proceed based on working drawings that are substantially, but not finally, approved.

The time period as shown above shall be doubled for submittals that require design computations with the drawings. The time will begin upon receipt by the Construction Division Office.

Each subsequent submission, if required, may require the same time period as the second submission. For the third and subsequent submissions, the Contractor shall bear the cost of

review as a rate of \$75/hour. The cost will be deducted from money due the Contractor.

In the event that the Contractor's first submission does not meet accepted industry standards for shop detail drawings or engineering design drawings and specifications, as determined by the Department, the entire submission will be returned without

review and will be recorded as the first submission and when resubmitted will be subject to the same time requirements as the first submission.

The Department will endeavor to return corrected and/or approved drawings with a minimum of delay. In order to expedite the approval of critical drawings, the Contractor should indicate in his submittal, the order of preference for review and return of drawings and should submit all drawings in the order of their importance.

If the Department's review requires a period longer than that stated above, the Contractor may request an extension of time under Subsection 108.06.

For the first and subsequent submittals, the Contractor shall submit three (3) sets of drawings, on the size sheets required; one set to the Resident Engineer, two sets to the Construction Office. One set of these drawings will be returned to the Contractor approved or marked with comments. After approval has been given, the Contractor shall furnish the Department with two (2) reproducible copies of the drawings. Final tracings on mylar or equivalent shall also be filed with the Department. Prior to the approval of the drawings, work done or materials ordered for the structures involved shall be at the Contractor's risk. All submittals shall be done using the same system of units as used in the original drawings.

Approval of the Contractor's working drawings relates to the requirements for strength and detail and such approval will not relieve the Contractor from responsibility for errors in dimensions, for successful completion of the project, or for responsibility for damage claims as defined in Subsection 107.15. The Contractor shall be responsible for the correctness of his plans and for shop fits and field connections, although the plans may have been approved.

The contract price shall include the cost of furnishing all working drawings and final tracings.

105.03 Conformity with Plans and Specifications. All work performed and materials furnished shall be in substantial conformity with the lines, grades, cross sections, dimensions and material requirements, including tolerances, as provided in the contract documents.

In the event the Engineer finds the materials or the finished product in which the materials are used, not in conformity with the contract documents but that reasonably acceptable work has

been produced, the Engineer will then make a determination if the work as produced shall be accepted and remain in place. In this event, the Engineer will document the basis of acceptance by contract modification which may provide for an appropriate adjustment in the contract price for such work or materials.

In the event the materials or finished product in which the

materials are used or the work performed are found not to be in conformity with the contract documents resulting in an inferior or unsatisfactory product, as determined by the Department, the work or materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor without liability to the Department.

105.04 Coordination of Contract Documents. All contract documents set forth in Section 101.15 and any supplementary documents shall constitute the contract and a requirement occurring in one document shall bind the Contractor as though occurring in all. In case of discrepancy, calculated dimensions shall govern over scaled dimensions; plans shall govern over Standard Specifications and Supplemental Specifications; Supplemental Specifications shall govern over Standard Specifications and Special Provisions shall govern over Standard Specifications, Supplemental Specifications and Plans. When the contract documents provide that new work is to connect with existing structures the Contractor must verify all dimensions before proceeding with the work.

The Contractor shall take no advantage of any error or omission in the contract documents. In the event the Contractor discovers any error or omission, he shall immediately notify the Engineer. The Engineer will then make written adjustments as may be necessary to fulfill the intent of the contract documents.

105.05 Cooperation by Contractor. The Contractor will be supplied free of charge with a maximum of 4 sets of plans and contract assemblies, including Supplemental Specifications and Special Provisions; one set of which the Contractor shall keep available on the work site.

The Contractor shall give the work the constant attention necessary to maintain its progress in accordance with the contract documents and shall cooperate with the Engineer, his Inspectors, utilities and other Contractors in every way possible.

The Contractor shall have on the work at all times, a competent English speaking Superintendent capable of reading and understanding the plans and specifications and experienced in the type of work being performed, who shall receive instructions from the Engineer or authorized representatives. The Superintendent shall have full authority to execute orders or directions of the Engineer without delay and to promptly supply such materials, equipment, tools, labor and incidentals as may be required. Such

superintendence shall be furnished regardless of the amount of work sublet.

The Contractor shall furnish the Engineer with a list of names, addresses and telephone numbers of the Contractor's personnel who may be reached in case of emergency during hours when no work is being performed. On weekends and during storms the Contractor shall alert certain of his personnel to stand by and

shall inform the Engineer of arrangements so made.

105.051 Preconstruction Conference. After the contract agreement has been executed and before the start of construction, the Engineer may schedule a preconstruction conference at which the Contractor's Superintendent must attend. To provide proper coordination between the work of the Contractor and the various utilities involved on the project, a representative of each affected utility shall attend the preconstruction conference. A report of the preconstruction conference will be prepared by the Engineer.

The Contractor shall submit an acceptable Schedule of Work not later than 10 days after the preconstruction conference. In preparing the Schedule of Work, consideration shall be given by the Contractor to the complexity of the work to be done by utilities. The Schedule of Work shall include a detailed schedule of the priorities of all operations involving the affected utilities. The agreement reached with utilities at the preconstruction conference shall be incorporated into the Schedule of Work.

The Schedule of Work shall be submitted, on forms furnished by the Department, indicating the order in which the Contractor proposes to do the work, including the date he will start and complete work on the various items. Submission of the first progress estimate will be contingent on acceptance of the Schedule of Work by the Department.

Revisions in the Contractor's Schedule of Work shall be set forth in a letter of notification and if such changes affect the operations of a utility, a minimum of 10 days notice shall be given for such revisions unless previous arrangements have been made with the utility company involved.

105.06 Cooperation with Utilities. In order that proper coordination may be obtained between the work of the Contractor and the work of various utilities, a preconstruction utility meeting will be required when called for in the Special Provisions. A representative of each affected utility, the Contractor or his representative authorized to make decisions for him in regard to the scheduling of the proposed work, will be required to attend the meeting. A report of the preconstruction utility meeting will be prepared by the Engineer.

The Department will notify affected utility companies and other parties in order that all necessary adjustments of public or private utility fixtures and appurtenances within the limits of construction are made as soon as practicable. Adjustments will

include temporary or permanent relocations which are required in the Department's opinion to permit convenient and safe construction of the project and any unforeseen conditions regarding any affected utility.

Pipe lines, gas lines, wire and cable lines, sewer lines, service connections, water and gas meter boxes, water and gas

valve boxes, light standards, cableways, signals, manholes and all other utility fixtures and appurtenances within the limits of the proposed construction will be relocated or adjusted by the owners without expense to the Contractor except as otherwise provided.

Where adjustments have not been completed and are not provided for in the contract documents the adjustments may be agreed upon at the preconstruction utility meeting or at a special meeting called for this purpose. Adjustments due to unforeseen conditions may be made by order of the Engineer or by written agreement at a special meeting. The decision of the Department in requiring adjustments by utilities and payment of the expense thereof shall be final.

For the Contractor's convenience, temporary changes of location of utility fixtures and appurtenances may be requested, which are not the responsibility of the Department. The Contractor shall satisfy the Department that the proposed temporary changes do not interfere with his or other Contractor's operations or the requirements of the work and do not cause obstructions or a hazard to traffic. The Contractor shall make his own request to the utility or other party affected by such temporary changes. The temporary changes shall be made solely at the Contractor's expense.

Any work done upon or within the right-of-way of a railroad shall be performed cooperatively with the Maine Department of Transportation by any such railroad through the Chief Engineer of the railroad or other designated officer, to mutually insure safe and uninterrupted operations and the convenient conduct of their respective businesses. Any additional conditions or requirements for doing work within the railroad right-of-way will be set forth in the Special Provisions.

The Contractor represents and warrants that the bid includes the cost of all permanent and temporary utility fixtures and appurtenances in their present or relocated positions as prescribed in the contract documents and that no additional compensation will be allowed for delays, inconvenience or damage sustained by the Contractor due to interference from utility fixtures and appurtenances or the operation of this Subsection.

The Contractor further covenants, represents and warrants that in the performance of all work for the Department under the contract documents, will fully comply with the requirements set forth in 23 M.R.S.A. Sec. 3360-A as amended, and will indemnify, defend and hold the Department harmless from any and all claims or causes of action arising from any act and/or omission of the

Contractor, the subcontractors or their respective agents, representatives or employees for violation or non-compliance with this Paragraph.

105.07 Cooperation Between Contractors. The Department reserves the right to contract for and perform other additional work on or near the work covered by the contract.

The Contractor shall arrange the work and shall place and dispose of the material being used so as not to interfere with the operations of other contractors within the limits of the same project. The Contractor shall join his work with that of other contractors in a manner and in sequence acceptable to the Department. In case of dispute the decision of the Engineer shall be final and binding upon all Contractors.

Each Contractor involved shall assume all liability, financial and otherwise, in connection with the contract and shall protect and save harmless the State from any and all damages or claims that may arise because of inconvenience, delay or loss because of the presence and operations of other contractors working within the limits of the same project. The Contractor shall assume all responsibility for work not completed or accepted because of the presence and operation of the other contractors.

105.08 Construction Stakes, Lines and Grades. Unless otherwise specified by special provisions, the Engineer will set reference stakes establishing lines, slopes, profile grade on road work, centerline and bench marks for bridge work, culvert work, protective and accessory structures and appurtenances as he may deem necessary; and will furnish the Contractor with all necessary information relating to lines, slopes and grades. These stakes and marks shall constitute the field control from which the Contractor shall establish other necessary controls and perform the work.

The Contractor shall be responsible for the preservation of all stakes and marks. If any of the construction stakes or marks have been destroyed or disturbed by the Contractor, the cost of replacing them by the State will be charged against the Contractor and will be deducted from money due the Contractor at a rate of 75.00 dollars per hour for each State survey crew, 2 to 4 men, used to replace the stakes or marks.

The Department, unless other provisions are made, will be responsible for the accuracy of lines, grades and other engineering work set forth under this section.

105.09 Authority and Duties of Resident Engineer or Resident Inspector. The Resident Engineer or Resident Inspector has immediate charge of each project, is responsible for the administration and satisfactory completion of the project and has the commensurate authority to reject defective material and to suspend work that is not being performed in accordance with the contract documents.

105.10 Inspection of Work. All materials and every detail of the work will be subject to inspection by the Engineer. The Engineer shall be allowed access to all parts of the work and shall be furnished with information and assistance by the Contractor required to make a completed and detailed inspection.

105.11 Duties of the Inspector. Departmental Inspectors, employed by the Department, are authorized to inspect work done

and materials furnished on any project. Inspection may extend to any part of the work and the preparation, fabrication or manufacture of the materials to be used. The inspector is not authorized to alter or waive the provisions of the contract, issue instructions contrary thereto or act as foreman for the Contractor.

Upon written request of the Engineer, the Contractor, at any time before acceptance of the work, shall remove or uncover portions of the finished work. After examination, the Contractor shall restore the work to the standards required by the contract documents. Should the work exposed or examined prove to be acceptable, the uncovering or removing and the replacing of the covering or making good of the parts removed, will be paid for as extra work. Should the work so exposed or examined prove to be unacceptable, the uncovering or removing and the replacing of the covering or making good of the parts removed will be at the Contractor's expense.

Any work done or materials used without supervision or inspection by an authorized Department representative may be ordered removed and replaced at the Contractor's expense unless the Department representative failed to inspect after having been given reasonable notice that the work was to be performed or the materials were to be used.

When any unit of government or political subdivision or any railroad is to pay a portion of the cost of the work covered by this contract, its respective representative shall have the right to inspect the work. Such inspection shall in no sense make any unit of government or political subdivision or any railroad a party to this contract and shall in no way interfere with the rights of either party hereunder.

105.12 Removal of Unacceptable and Unauthorized Work. Except as provided in subsection 105.03 all work which does not conform to the contract documents will be considered unacceptable.

Unacceptable work found to exist prior to the final acceptance of the project, caused by any reason whatsoever, including, but not limited to poor workmanship, use of defective materials, damage through carelessness, neglect, accident or otherwise, shall be removed immediately and replaced at the Contractor's expense.

No work shall be done without lines and grades having been given unless otherwise authorized. Work performed contrary to the instructions of the Engineer, before preliminary measurements are made, work done without proper inspection, work done beyond the

lines shown on the contract documents, except as herein specified or any extra work done without authority evidenced by a prior written agreement thereto, will be considered unauthorized and will not be paid for under the provisions of the contract. Work so done shall be ordered removed or replaced at the Contractor's expense, except as otherwise provided herein.

When material is fabricated or treated with another material or where any combination of materials is assembled to form a finished product, any or all of which are covered by specifications, the failure of any of the components of the product to comply with the designated specifications may be sufficient cause for the rejection of the whole.

Materials shipped from approved deposits or sources of supply which are found to be defective upon arrival at destination shall not be used.

105.13 Load Restrictions. The Contractor shall comply with load restrictions provided under 29 M.R.S.A. Sec. 903 as amended or pursuant to other laws or Departmental regulation for hauling of material or equipment on public roads beyond the limits of the project. A special permit will not relieve the Contractor of liability for such damage which may result from moving of equipment in violation of said restrictions.

For roads within the project, hauling materials over the base courses or surface course under construction shall be limited to legal loads. The Contractor shall not operate equipment of such weight or so loaded as to cause damage to structures or the roadway or to any other type of construction. In no case shall legal load limits be exceeded unless permitted by the by the Department in writing, with the exception of equipment used in grading operations, which includes the preparation of the subgrade prior to placing the subbase course. The Contractor shall be responsible and shall pay for all repairs for damage done under this Subsection.

105.14 Approaches and Access. Approaches, accesses or crossovers other than public ways, contemplated by the Contractor, shall be approved prior to their construction. Approaches, accesses or crossovers shall be removed, the ground restored to its original contour and the area loamed, seeded and mulched. This work will not be paid for directly but shall be considered included in the work of the contract.

105.15 Maintenance During Construction. The Contractor shall maintain the work during construction and until the project is accepted. This maintenance shall be day by day, continuous and effective with adequate equipment and forces to keep the roadway and structures in a satisfactory condition.

The Contractor shall provide a sufficient number of watchmen and take all precautions for the protection of the work and the safety of the public for all work not provided for in Section 652

-- Maintenance of Traffic. This work will not be paid for directly but will be considered included in the work of the contract.

When a contract is for placing a course upon a course or upon subgrade previously constructed, the Contractor shall maintain the previously constructed course or subgrade during all construction operations.

Costs of maintenance work during construction and before the project is accepted shall be included in the unit prices bid on the various work items. Such work will not be paid for directly but shall be considered included in the work of the contract.

105.16 Failure to Maintain Roadway or Structure. If the Contractor fails to comply with the provisions of Subsection 105.15, the Engineer will notify the Contractor of such failure. If the Contractor fails to provide satisfactory maintenance immediately after receipt of the notice, the Engineer may proceed to maintain the project and the entire cost of this maintenance will be deducted from monies due or to become due the Contractor.

105.17 Acceptance.

- (a) Partial Acceptance. If at any time during the progress of the work the Contractor completes a unit or portion of the project, such as a structure, an interchange or a section of road or pavement, he may request the Engineer to make final inspection of that unit. If the Engineer finds upon inspection that the unit has been completed in compliance with the contract, he may accept that unit and the Contractor may be relieved of further responsibility for that unit. Such partial acceptance shall in no way void or alter any of the terms of the contract.
- (b) Final Acceptance. Upon notice from the Contractor of completion of the entire project, the Engineer will make an inspection. If all construction provided for and contemplated by the contract documents is found completed to his satisfaction, that inspection shall constitute the final inspection and the Engineer will make the final acceptance and notify the Contractor in writing of this acceptance as of the date of the final inspection.

If the inspection discloses any work, in whole or in part, as being unsatisfactory, the Engineer will give the Contractor the necessary instructions for correction and the Contractor shall immediately comply with and execute such instructions. Upon correction of the work, another inspection will be made which will constitute the final inspection provided the work has been satisfactorily completed. In such event, the Engineer will make the final acceptance of the project and notify the Contractor in writing thereof as of the date of final inspection.

105.18 Claims for Adjustments and Disputes. If the Contractor claims additional compensation is due him for work or material not clearly specified in the contract documents or not ordered as

extra work as specified under Subsection 101.29, the Contractor shall notify the Engineer in writing of his intention to make a claim for additional compensation before he begins the work on which he bases the claim. If notification is not given and the Engineer is not given an opportunity to keep account of actual costs, the Contractor hereby agrees to waive any claim for such

1-60h additional compensation.

Notice by the Contractor and the fact that the Engineer has kept account of the cost shall not be construed as substantiating the validity of the claim. If the claim is found to be just it will be paid as extra work as provided for force account work. Nothing in this Subsection shall be construed as establishing any claim contrary to the terms of Subsection 104.02.

105.19 Access to Contractor's Records. The Contractor and his Subcontractors shall make foreman's daily time reports, records of force account work, employment records, payrolls and other documents substantiating payment, available for inspection by authorized representatives of the Department and shall permit such representatives to interview employees during working hours. These records shall be retained for a period of at least 3 years after acceptance of the project.

105.20 Cost Reduction Incentive. The Contractor may submit written proposals, to modify the contract documents for the sole purpose of reducing the total cost of construction. The cost reduction proposal shall not impair in any manner the essential functions or characteristics of the project, including but not limited to service life, economy of operation, ease of maintenance, desired appearance or design and safety standards.

The proposals shall be identified as Cost Reduction Incentive proposals and shall contain the following information:

- (a) A description of both the existing contract requirements for performing the work and the proposed changes.
- (b) An itemization of the contract requirements that must be changed if the proposal is adopted.
- (c) A detailed estimate of the cost of performing the work under the existing contract and under the proposed change.
- (d) A statement of the time within which the Engineer must make a decision thereon.
- (e) The contract items of work affected by the proposed changes, including any quantity variation attributable thereto.

The provisions of this Subsection shall not be construed to require the Engineer to consider any cost reduction proposal which may be submitted, nor shall it be construed to require the

Contractor to follow these procedures for all contractor requested changes which might result in a savings to the contract. Proposed changes in basic design of a bridge or of a pavement type will not be considered as an acceptable cost reduction proposal. The Department will not be liable to the Contractor for failure to accept or act upon any cost reduction proposal submitted pursuant

1-61ant to this section nor for any delays to the work attributable to any such proposal. If a cost reduction proposal is similar to a change in the plans or specifications for a project under consideration by the Department at the time the proposal is submitted or if a proposal is based upon or similar to, Standard Specifications, Special Provisions or Standard Plans adopted by the Department after the advertisement for the contract, the Engineer will not accept the proposal and the Department reserves the right to make such changes without compensation to the Contractor.

The Contractor shall continue to perform the work in accordance with the requirements of the contract until an executed change order incorporating the cost reduction proposal has been issued. If an executed change order has not been issued by the date upon which the Contractor's cost reduction proposal specifies that a decision thereon should be made or such other date as the Contractor may subsequently have specified in writing, such cost reduction proposal shall be deemed rejected.

The Engineer shall be the sole judge of the acceptability of a cost reduction proposal and of the estimated net savings from the adoption of all or any part of such proposal. In determining the estimated net savings the right is reserved to disregard the contract bid prices if, in the judgment of the Engineer, such prices do not represent a fair measure of the value of work to be performed or to be deleted.

The Department reserves the right, where appropriate, to require the Contractor to share in the Department's costs of investigating a cost reduction proposal submitted by the Contractor as a condition of considering such proposal. Where a condition is imposed, the Contractor shall indicate his acceptance thereof in writing and the acceptance shall constitute full authority for the Department to deduct amounts payable to the Department from any monies due or that may become due to the Contractor under the contract.

If the Contractor's cost reduction proposal is accepted in whole or in part, the acceptance will be by a contract change order which shall specifically state that it is executed pursuant

to this Subsection. The change order shall incorporate the changes in the plans and specifications which are necessary to permit the cost reduction proposal or that part of it which has been accepted and shall include any conditions upon which the Department's approval thereof is based if the approval of the Department is conditional. The change order shall also set forth the estimated net savings in the cost of performing the work attributable to the cost reduction proposal. All reasonably incurred costs of developing the cost reduction proposal and of implementing the changes will be deducted from the total estimated decrease in the Contractor's cost of performance to arrive at the net savings amount. The contract change order shall further provide that the Contractor be paid 50 percent of the net savings amount.

The amount specified to be paid to the Contractor in the change order for a cost reduction proposal shall constitute full compensation to the Contractor for the cost reduction proposal and the performance of the work thereof.

Acceptance of the cost reduction proposal and performance of the work shall not extend the time of completion of the contract unless specifically provided for in the change order authorizing the use of the cost reduction proposal.

The Department reserves the right to adopt a cost reduction proposal for general use on contracts administered by the Department when it determines that the proposal is suitable for application to other contracts. When an accepted cost reduction proposal is adopted for general use, only the Contractor who first submitted such proposal will be eligible for compensation pursuant to this section and in that case, only as to those contracts awarded to him prior to submission of the accepted cost reduction proposal. Cost reduction proposals identical or similar to previously submitted proposals will be eligible for consideration and compensation under the provisions of this Subsection if the identical or similar previously submitted proposals were not adopted for general application to other contracts administered by the Department. Subject to these provisions, the State or any other public agency shall have the right to use all or any part of any submitted cost reduction proposal without obligation or compensation of any kind to the Contractor.

SECTION 106 -- CONTROL OF MATERIAL

106.01 Source of Supply and Quality Requirements. The materials used on the work shall meet the quality requirements of the contract documents at the time they are incorporated into the work. To expedite inspection and testing of materials, the Contractor shall notify the Engineer of his proposed sources of materials sufficiently prior to delivery to allow time for testing. Representative samples of materials may be taken at the source of supply by the Engineer before delivery is started. If after trial, it is found that sources of supply for previously approved materials do not produce specified products, the Contractor shall furnish materials from other sources. All material will be tested and accepted as specified in the contract.

Samples of materials for tests, upon which the acceptance or rejection is to be based, will be taken by the Engineer either

prior to shipment or after being received at the place of construction. Sampling, inspection and testing shall be done in accordance with the methods hereafter specified. The Contractor shall provide facilities, as the Engineer may require, for conducting field tests and for collecting and forwarding samples. All liquid and cement bituminous material bulk delivery and distributors shall be equipped with an acceptable sampling valve.

The Contractor shall not use or incorporate into the work any

materials represented by preliminary samples until tests have been made and the material found to be acceptable unless otherwise authorized. Only materials which have been approved shall be incorporated in the work. It is the Contractor's responsibility to perform the work and supply materials using methods and equipment that will not cause the materials to change to the extent that they might be out of compliance with the specification for the particular material during or after placing on the roadway. Any material which, after prior approval has been obtained, has for any reason become unfit for use or outside of its specification limit, shall not be incorporated in the work.

106.02 Local Material Sources.

- (a) Designated Sources. Possible sources of local materials may be designated on the plans and described in the special provisions. The quality of material in such source may be acceptable but the Contractor shall determine for himself the amount of equipment and work required to produce material meeting the specifications. It shall be understood that it is not possible to determine from samples, the limits for an entire source. Variations shall be considered as usual and are to be expected. The Engineer may order procurement of material from any portion of a deposit and may designate portions of the deposit as unacceptable without liability to the Department.

The Department may acquire and make available to the Contractor the right to take materials from the sources designated on the plans and described under special provisions, together with the right to use such property as may be specified.

- (b) Contractor Furnished Sources. If the Contractor elects to use material from sources other than those designated, he shall acquire the necessary rights to take material from those sources and he shall pay all costs related thereto, including any which may result from an increase in length of haul. All costs of exploring and developing such sources shall be borne by the Contractor. Before the removal of any material from the source for use on the project the source must have the approval in writing. In addition to providing acceptable material, a condition of approval will be the acceptability of the arrangements for rehabilitation of the site. These arrangements shall be incorporated into an agreement between the land owner and the Contractor. The Engineer shall be furnished a copy of the agreement. The Contractor shall also certify in writing that the

existence of the pit and his operation complies with state and local ordinances and regulations.

106.021 Pit Rehabilitation. Unless pit owners and the Contractor agree to pit rehabilitation, including loam fields, under whichever condition specified below applies, use of the 1-66 source will not be authorized.

- (a) Newly opened pits and loam fields from which any material has been removed for the project shall be completely rehabilitated.
- (b) Areas of extensions of existing pits from which common borrow, granular borrow, gravel borrow, rock borrow or loam have been removed for the project shall be completely rehabilitated.
- (c) Areas of extensions of existing pits which have become depleted by the removal of other gravel, sand, aggregate items or loam for the project shall be completely rehabilitated.
- (d) Areas of extensions of pits which have not become depleted by the removal of other gravel, sand, aggregate items or loam shall be rehabilitated to the extent of grading the slopes to 1 vertical to 1 horizontal or flatter.

Depleted shall be interpreted to mean when the only remaining material is within 3.05 m {10 feet} of a property line on a 1 vertical to a 2 horizontal slope or when the character of the material so radically changes that it can not longer be used as originally anticipated.

Completely rehabilitated shall be interpreted to mean grading of all areas disturbed as a result of the project and treating of the ground surface in accordance with Section 657, Rehabilitation of Pits.

Surface material stripped from the pit shall be placed in such a manner that it can be used advantageously for restoration of the pit; however, it is not intended that the stripping be placed on top of areas of anticipated future operations.

The Contractor shall not excavate from pit faces which are vertical or have an overhang. The Contractor must stop excavating within a 1 vertical to 2 horizontal slope 3.05 m {10 feet} inside of a property line of a deposit, even though the material within the pit will remain at a steeper angle of repose. The exception may be when an additional agreement is reached with an adjacent property owner which will allow the extension of a pit onto the adjacent property owner's land. The Contractor must insure that

hazards such as steep pit faces and ponds are protected by flattening slopes or by the erection of suitable fencing.

106.03 Samples, Tests, Cited Specifications. Materials will be inspected, tested and accepted as specified in Subsection 106.01. Work in which untested and unaccepted material is used without approval or written permission will be at the Contractor's risk and the work may be considered unacceptable and unauthorized

1-67zed and may not be paid for. When specifications, materials, procedures, designs or testing methods are designated to conform to AASHTO, ASTM, MUTCD or other cited organization, the designation shall mean the most recent cited standard or interim specification procedures or methods current on the date of advertisement for bids. Samples for testing will be taken by qualified representatives of the Department and shall be furnished by the Contractor at no cost to the State.

Unless otherwise designated, tests will be made at the expense of the Department. Materials being used are subject to inspection, testing or rejection at any time prior to incorporation into the work. Copies of test reports will be furnished to the Contractor's representative upon request.

106.04 Plant Inspection. The Engineer may inspect the materials at the plant and the following conditions shall be met:

- (a) The Engineer shall have the cooperation and assistance of the Contractor and the producer with whom the Contractor has arranged for materials.
- (b) The Engineer shall have full access at all times to the parts of the plant which concern the manufacture and production of the materials being furnished.
- (c) If required, the Contractor shall arrange for an approved testing laboratory building for the use of the Inspector. The building shall be located near the plant and conform to the requirements of Section 639 -- Engineering Facilities.
- (d) Adequate safety measures shall be provided and maintained.

The Department reserves the right to retest material, after the material has been accepted at the source, delivered to the project and before the material is incorporated into the work and to reject all retested materials which does not meet the requirements of the specifications.

106.05 Vacant

106.06 Storage of Materials. Materials shall be stored to assure the preservation of their quality and fitness for the work. The method of storage shall be subject to approval. Stored materials, even though approved before storage, may again be inspected prior to their use in the work. Stored materials shall be located to facilitate their prompt inspection. Portions of land within the right-of-way may be approved for storage purposes and for the placing of the Contractor's plant and equipment, but any additional land required shall be provided by the Contractor at

1-68t his expense. Private property shall not be used for storage purposes without written permission of the owner. Copies of the written permission shall be furnished upon request. All storage sites, either within the right-of-way or on private property, shall be restored to original condition by the Contractor at his expense at the completion of the project. The provisions of this subsection shall not apply to the stripping and storing of top-soil or to other materials salvaged from the work.

106.07 Handling Materials. All materials shall be handled in such manner as to preserve their quality and fitness for the work. Aggregates shall be transported from the storage site to the work in tight vehicles to avoid loss or segregation of materials after loading and measuring in order that there may be no inconsistencies in the quantities and quality of materials intended for incorporation in the work and the quantities and quality of such material actually received at the construction site.

106.08 Unacceptable Materials. Materials not conforming to the specifications at the time they are used will be unacceptable and will be rejected and shall be removed immediately from the work site unless otherwise instructed in writing. Any rejected material which has been corrected shall only be used after written approval is obtained.

106.09 Department Furnished Material. The Contractor shall furnish all materials required to complete the work, except those specified to be furnished by the Department. Material furnished by the Department will be delivered or made available to the Contractor at the points specified in the special provisions. All cost of handling and placing materials after they are delivered shall be considered as included in the contract price for the item under which they are used.

The Contractor will be held responsible for all Department furnished material delivered to him and deductions will be made from any monies due to make good all shortage and deficiencies, from any cause whatsoever, and for any damage which may occur after such delivery and for any demurrage charges.

SECTION 107 -- LEGAL RELATIONS WITH AND RESPONSIBILITY TO PUBLIC

107.01 Laws to be Observed. The Contractor shall keep fully informed of all Federal, State, and local laws, ordinances, rules and regulations and all orders and decrees of bodies or tribunals having any relevant jurisdiction or authority, which in any manner affect the work or those engaged or employed on the project. He shall at all times observe and comply with all such laws, ordinances, rules, regulations, orders and decrees, and shall indemnify defend and hold the Department and its agents, representatives and employees harmless against any and all claims

or liabilities arising from or based on the violation of any such law, ordinance, rule, regulation, order or decree, whether caused either directly or indirectly by the Contractor, any subcontractor or their respective employees, agents, or representatives.

107.02 Permits, Licenses and Taxes. The Contractor shall procure all permits and licenses, pay all charges, fees and taxes and give all notices necessary and incidental to the due and lawful prosecution of the work.

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

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 to construct or reconstruct is, at any time during construction, hereby expressly reserved by the Department. The Contractor shall not be entitled to any damages for unauthorized digging or any delay occasioned thereby.

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 such permits and only those parties, to make openings in the highway. When ordered, the Contractor shall make all necessary repairs due to such openings and such necessary work will be paid for as extra work or as provided for in the special provisions and will be subject to the same contract conditions as the original work performed.

107.05 Federal Aid Provisions. 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 must be observed by the Contractor. The reports and the records enumerated in Subsection 105.19 and the work shall be subject to the inspection by the appropriate Federal agency.

Such inspection shall not make the Federal Government a party to this contract and will not interfere with the rights of either party of this contract.

107.06 Sanitary Provisions. The Contractor shall provide and maintain in a neat, sanitary condition such accommodations for the use of his employees as may be necessary to comply with the requirements of the State and Local Boards of Health or of other bodies or agencies having like jurisdiction. In providing these accommodations, the Contractor shall prevent the occurrence of any

inconvenience, noxious odors or fumes or nuisance to the public residents or others in the vicinity of the work.

107.07 Public Convenience and Safety. The Contractor shall at all times conduct his work to assure the safety of and the least possible obstruction to pedestrian, vehicular and marine traffic. The safety and convenience of the general public and the residents along the highway and the protection of persons and property shall be provided for by the Contractor as specified under Subsection 105.15.

Fire hydrants on or adjacent to the highway shall be kept accessible to fire apparatus at all times. Footways, gutters, sewers, inlets and portions of the highway, adjacent to the work under construction, shall not be obstructed more than is necessary.

107.08 Railway-Highway Provisions. If the plans require materials to be hauled across the tracks of any railroad, the Department will make preliminary arrangements with the railroad to permit crossings required or to permit the use of any existing private crossings. The Contractor shall negotiate and enter any necessary agreements with the railroad pertaining to construction, maintenance and protection of the crossing and shall pay, as an expense incidental to the contract, all costs applicable thereto. If the Contractor elects to use crossings other than those shown on the plans described in the special provisions he shall make his own arrangements for the use of such crossings.

Work to be performed by the Contractor in construction on a railroad right-of-way shall be performed at a time and in a manner not to unnecessarily interfere with the movement of trains or traffic of the railway company. The Contractor shall use precautions to avoid accidents, damage or unnecessary delay or interference with the railway company's trains or other property. Work on a railroad right-of-way shall conform to provisions of Subsection 105.06.

107.09 Bridges Over Navigable Waters. Work on navigable waters shall not interfere with free navigation of the waterways and shall not impair navigable depths and widths except as allowed by permit issued by the US Coast Guard and other applicable regulatory agencies.

107.10 Water Traffic and Stream Discharge. The Contractor shall provide for water traffic to pass under or through the bridge. Whenever a movable span is included in the work the Contractor shall provide a clear and unobstructed opening having

a width conforming to the lesser dimensions secured by either the old or the new structure and shall provide and maintain such sights, signals and other warnings as may be required for public safety and convenience or to conform with Federal regulations.

Expenses connected with the maintenance of water traffic and losses arising from unforeseen obstruction or difficulty encountered in connection therewith or from delay or hindrance

from any cause resulting therefrom shall be borne by the Contractor and shall not constitute a claim for extra compensation or for an extension of time for the completion of the contract.

During construction and until completion of the work the Contractor shall provide a waterway ample and efficient for stream discharge. All debris dropped into the streambed, as the result of the Contractor's operations, shall be removed by the Contractor who will be responsible for all damage which may result from such water backing up or flowing over, through, from or along any part of the work or which any of the Contractor's operations may cause to flow elsewhere. Furthermore the Contractor will be held responsible for all damage caused by or resulting from lowering the elevation of the water in the stream by reason of his operations.

107.11 Vacant

107.12 Use of Explosives. When the use of explosives is necessary to perform the work the Contractor shall use utmost care to protect life and property, including all work required under the contract documents. The Contractor shall be responsible for and shall indemnify, defend and hold the Department harmless against any and all claims for damage resulting from the use of explosives.

All explosives shall be stored in a secure manner in compliance with the latest rules and regulations for the keeping of explosives as set forth by the State Insurance Department and local laws and ordinances. All explosive storage places shall be clearly marked.

The Contractor shall notify each utility, having structures close to the work, of his intention to use explosives. The notice shall be given sufficiently in advance to enable the utilities to protect their property from damage. Such notice shall not relieve the Contractor of responsibility for any damage, whether direct or indirect, resulting from the blasting operations.

Any site where there are electric blasting caps or where explosive charges are being placed or have been placed shall be designated as a Blasting Zone. A Blasting Zone shall be marked by approved signs in accordance with the MUTCD.

The signs shall be conspicuously placed at each end of the Blasting Zone and shall remain in place only while blasting conditions are in effect and shall be removed after the blast and after all caps have been removed from the area.

All persons and adjacent property within the danger zone of blasting operations shall be warned by the Contractor and no blasting shall be done until the zone is cleared. Sufficient flagmen, furnished by the Contractor, shall be stationed outside

the danger zone to stop all approaching traffic during blasting operations.

Before blasting the Contractor shall have adequate equipment available, to remove debris from the traveled way to restore normal traffic flow with a minimum of delay.

Watchmen shall be provided by the Contractor during the loading period and until the charges have been exploded.

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

The Contractor shall not enter private property without first obtaining permission the owners.

The Contractor shall be responsible for all damage or injury to property of any kind, during the prosecution of the work, resulting from any act, omission, neglect or misconduct in his manner or method of executing the work or at any time due to defective work or materials and said responsibility will not be released until the project has been completed and accepted.

When or where there is any direct or indirect damage or injury to public, private or Departmental property by or on account of any act, omission, neglect or misconduct in the execution or non-execution of the work by the Contractor, he shall restore, at his own expense, such property to a condition substantially equal to that existing before such damage or injury was done, by repairing, rebuilding or otherwise restoring said property in a manner acceptable to the Department.

In the event the Contractor fails to restore or make good such damage or injury, the Engineer may, upon 48 hours advance written notice, proceed to repair, rebuild or otherwise restore damaged property as necessary without liability to the Department and the cost thereof will be deducted from monies due or which may become due the Contractor under the contract.

107.14 Forest Protection. In carrying out work within or adjacent to State or National Forests, the Contractor shall comply with all regulations of the State Fire Marshals Office, Forestry Department or other authority having jurisdiction governing the protection of forests and the carrying out of work

within forests and shall observe all sanitary laws and regulations with respect to the performance of work in forests. He shall keep the forests 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 precautions to prevent and suppress fires and he shall require employees and subcontractors, to notify a forest official at the earliest moment of the location and extent of any fire seen by them and to do everything reasonable within their power to prevent and suppress and to assist in preventing and suppressing fires.

107.15 Responsibility for Damage Claims. The Contractor shall indemnify, defend and hold the Department and its officers, agents, representatives and employees harmless from any and all claims, actions, causes of action, losses, expenses, damages, and any and all other liabilities of any character whatsoever resulting in any injuries or damage to any person, entity or property arising out of any act and/or omission of the Contractor, any subcontractors or their respective agents, representatives or employees. Without limiting the applicability of the foregoing, the Contractor shall indemnify the Department, as provided in this Subsection, for any and all negligent, willful and wanton, intentional, malicious or criminal acts and/or omissions arising out of any aspect of the project, including but not limited to any neglect in safeguarding the work; the use of unacceptable materials in constructing the work, any failure on any portion of the project, any claims or amounts recovered from infringements of patent, trademark or copyright rights of any party from claims or amounts arising or recovered under the "Workmen's Compensation Act" or other similar law, ordinance, order or decree, or any claim arising out of work performed or materials provided by any Subcontractor with respect to any part of the project. The Department, may retain for its exclusive use, without recourse by the Contractor or anyone claiming under him, any and all amounts due the Contractor as provided under the contract documents to assure Contractor's compliance with this Subsection. In the event all retained funds are insufficient to fully indemnify the Department hereunder, the Contractor's insurance carrier and surety shall be held jointly and severally liable with the Contractor to the Department until this Subsection is complied with in full. In addition, the Contractor's insurance carrier and surety shall be mutually responsible to resolve any and all claims, actions, causes of action, losses, expenses, damages and any and all other liabilities for any injuries, death or property damage sustained by any person or entity as a result of any work performed on the project. The Contractor shall provide written confirmation satisfactory to the Department that all such actions have been fully resolved prior to final payment under Subsection 109.10.

The Contractor shall promptly pay all bills for services, labor, materials, machinery, water, tools, equipment, trucks,

automobiles, freight, fuel, light and power and for all other goods contracted for or used by the Contractor on account of the work. If at any time during the progress of the work or before final payment of any money due the Contractor under the terms of this contract, any claim for services, labor, materials, water, tools, equipment, trucks, automobiles, freight, fuel, light and

power or for any other goods specified as aforesaid or for damages by reason of any acts, omissions or neglect of the Contractor in the prosecution of the work, shall be presented to the Department, the Department may retain monies due the Contractor as would be necessary to discharge all claims whether for services, labor, materials or damages when the validity of such claims is established by a court or tribunal of competent jurisdiction. If said court or tribunal determines that such claims are invalid and groundless, any amount so retained shall be paid to said Contractor or in case of default hereunder to the Contractor's surety. The Contractor hereby affirmatively represents and warrants that the Department shall not incur any liability to any individual, firm, partnership, joint venture, sole proprietorship or any other entity or corporation making such claims for failure or refusal to hold and retain any amounts due for purposes of this Subsection. The Department, at its option and with the written consent of the Contractor, may use any monies due or to become due under this contract for the purpose of paying any claims of the Contractor. Any and all claims for goods, services, labor or materials provided for the project shall be filed in writing with the Department within 90 days after delivery of final goods, services, labor and materials and shall be only for final payment for such goods, services, labor and materials. Failure to file a claim as provided hereunder shall constitute a waiver of the claim with respect to the Department and shall further constitute a release of any liability against the Department by the claimant for retained funds being returned to the Contractor upon completion of the project in accordance with the contract documents. Should the Contractor

fail to pay any undisputed claim made in writing to the Department within 30 days after receipt by the Department of said claim, the Department may provided sufficient retained contract funds are available, pay such claim and deduct the amount thereof from the balance due the Contractor.

If the Contractor fails to discharge any claim whether disputed or undisputed in whole or in part, which is made in writing to the Department within the period set forth above, the Department may, after written notice to the surety, make final payment to the Contractor under the provisions of Subsection 109.10, less any retained funds required to be held by the Department under applicable law.

107.16 Third Party Beneficiary. No provision contained in the contract documents shall establish in favor of any person or entity the status of a third party beneficiary hereunder or to authorize anyone not a party hereto to maintain any action or

proceeding hereunder. The duties, obligations and responsibilities of the parties to this contract, with respect to third parties, shall be as provided by the laws of Maine.

107.17 Opening Sections of Project to Traffic. At the option of the Engineer, sections of the work may be opened for traffic. Opening shall not constitute acceptance of the work or any part thereof or a waiver of any provisions of the contract; provided,

however, that on such portions of the project completed and accepted, the Contractor will not be required to assume the expense of maintaining the roadway for traffic. Such expense will be borne by the Department as provided in Subsection 104.03 for extra work.

Any damage to the highway not attributable to traffic which occurs on uncompleted sections, except earth slides, shall be repaired by and at the expense of the Contractor. The removal of earth slides shall be done by the Contractor on a basis agreed to prior to the removal of the slides.

If the Contractor is dilatory in completing shoulders, drainage structures or other features of the work, the Engineer may order all or a portion of the project open to traffic and the Contractor will not be relieved of his liability and responsibility during the period the work is so opened prior to final acceptance. The Contractor shall conduct the remainder of the construction operations to cause the least obstruction to traffic and in accordance with Section 652 -- Maintenance of Traffic.

107.18 Contractor's Responsibility for Work. Until final written acceptance of the project, the Contractor shall have the charge and care thereof and shall take every precaution against damage to any part thereof by the action of the weather elements or from the non-execution of the work. The Contractor shall rebuild, repair, restore and make good, at the Contractor's expense, all damages to the work caused by any of the above before final acceptance. Damage to the work due to unforeseeable causes beyond the control of the Contractor as determined by the Department, including but not restricted to events of nature, the public enemy or governmental authorities shall be repaired by the Contractor with the approval and under the direction of the Engineer and paid for at the respective contract unit prices for the quantities and items of work involved. In a contract for the placing of a base course or surface course or courses upon previously constructed and completed work, the Contractor will be required to maintain the previously constructed work concurrently with the operations for the entire project.

In case of suspension of work from any cause whatsoever, the Contractor will be responsible for the project and shall take precautions as may be necessary to prevent damage to the project, provide for normal drainage and shall erect any necessary temporary structures, signs or other facilities the Contractor's expense. During such period of suspension of work, the Contractor shall continuously maintain, in an acceptable growing condition

of all living material in newly established plantings, seedings and soddings furnished under the contract and shall take precautions to protect new tree growth, vegetation growth and other important against damage.

107.19 Contractor's Responsibility for Utility Property and Services. When the Contractor's operations are adjacent to

properties of railway, water, sewer, gas, cable television, telephone and power companies or are adjacent to other property where damage might result in considerable expense, loss or inconvenience, work shall not be commenced until all arrangements for their protection have been made.

The Contractor shall cooperate with the owners of underground and overhead utility lines in their removal and rearrangement operations that these operations may progress in a reasonable manner, that duplication of work may be reduced to a minimum and that services will not be unnecessarily interrupted. In performing the work, the Contractor shall fully comply with all provisions of 23 M.R.S.A. Sec. 3360-A, entitled "Protection of Underground Facilities". The Contractor shall indemnify, defend and hold the Department harmless for any and all claims, actions or causes of action brought by any party due to lack of compliance with this Paragraph by the Contractor, the Contractor's agents, representatives, employees and subcontractors.

The Contractor shall use suitable precaution to prevent damage to pipes, conduits and other underground structures and to poles, wires, cables and other overhead structures, whether or not shown on the plans. Arrangements for special protection of utility plant, when needed, shall be made by the Contractor with the utility in advance of construction operations.

If utility services are interrupted as a result of accidental breakage or as a result of utility plant being exposed or unsupported, the Contractor shall promptly notify the proper utility and shall cooperate in the restoration of service. If service is interrupted, repair work will be continuous until the service is restored. No work shall be undertaken around fire hydrants until provisions for continued services have been approved by the local fire authority.

Telephone cable plastic components have a softening point of 80 °C {176 °F} and a melting point of 110 °C {230°F}. The Contractor shall not build fires near cable lines which produce temperatures around the cable in excess of 65 °C {150°F} and fires will not be allowed when the wind direction is from the fire towards the cable line. Protection of the cable line from damage shall be the responsibility of the Contractor.

107.20 Furnishing Right-of-Way. The Department will be responsible for securing necessary right-of-way in advance of construction. Any exceptions will be indicated in the contract.

107.21 Personal Liability of Public Officials. In carrying out the provisions of the contract documents, the Department and its agents, employees and representatives, either personally or in their official capacity for the Department, shall incur no liability hereunder other than that specifically provided for under State or Federal law.

107.22 No Waiver of Legal Rights. The Department 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 therefore 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 documents. The Department 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, such damage as it may sustain by reason of the Contractor's failure to comply with the terms of the contract documents. Neither the acceptance by the Department or any representative of the Department, 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 or subsequent breach.

107.23 Minimum Wages. The wages for an hour's work paid to employees in the various classifications, as designated in the proposal, shall not be less than the wage rates set forth in the contract. This provision, pertaining to wages, shall apply to all work performed on the project by the Contractor with his own organization and to all work performed by a subcontractor.

107.24 Safety and Accident Prevention. The Contractor shall fully comply with all applicable Federal, State and local laws governing safety, health and sanitation. The Contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions, on his own responsibility or as the Engineer may determine reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract documents.

107.25 Historical Deposits. Activities that would cause a disturbance to any object of archaeological, paleontological or other historical interest shall immediately cease and shall not be resumed until an investigation of the deposit has been completed and the removal of articles of interest has been accomplished. Should such a deposit be uncovered the Contractor or the Engineer shall notify the Department immediately.

The first indication of archaeological deposits may be the burial grounds or campsites of Indians, revealing the bones of

the dead and their implements. The first indications of paleontological deposits may be the exposure of marine fossils or shells found mainly in clay deposits. Indications of deposits of more recent historical interest may be the exposure of dumps in landfill areas, abandoned campfire sites and building foundations.

Delay of the Contractor's operations in the event of the

above shall not be compensated for directly and shall be considered incidental to general items in the contract but may be justification for adjustment of working days or calendar days if a delay involves one or more working days or calendar days.

The Contractor's attention is directed to Chapter 398 of MRS Title 27 §371, which places the ownership with the State of Maine of artifacts, specimens and material which are public property by virtue of having been found on, in or beneath State controlled lands.

107.26 Soil Erosion and Water Pollution Control. The Contractor shall control soil erosion, sedimentation and water pollution by the use of temporary and permanent erosion control measures specified in the contract continuously throughout the construction and post-construction period. The temporary erosion control measures shall be continued until the permanent facilities have been constructed and until the grass on seeded slopes is sufficiently established to be an effective erosion deterrent. The erosion control features shall be maintained by the Contractor in a manner acceptable to the Department.

In case of failure by the Contractor to control erosion, sedimentation and/or pollution, the Engineer reserves the right to use State forces to provide the necessary corrective measures. Such incurred direct costs plus project engineering costs will be charged to the Contractor and appropriate deductions made from the Contractor's progress payment estimate.

Temporary pollution control may include construction work outside the right-of-way where work is necessary as a result of roadway construction such as borrow pit operations, haul roads and equipment storage sites.

These protective requirements will also apply to aggregate preparation, borrow pit, mixing plant, waste disposal, equipment storage and hauling operations. The Contractor shall provide all necessary ditches, sedimentation ponds, dikes or other devices deemed necessary. Pits plant sites, waste areas and haul roads which are developed in areas where no such activities existed prior to this contract, whether in sight of the road or not, shall be graded smooth, loamed, seeded and mulched upon completion of the work. This requirement shall also apply to the expansion of existing sites but only to that area affected by the expansion.

- (a) Preconstruction Conference. At the preconstruction conference, or prior to the start of construction not including clearing and tree removal, the Contractor

shall submit the Schedule of Work which shall include proposed methods and procedures for site specific temporary and permanent erosion and pollution control during the construction of the project and until all permanent erosion control features have been established. The Contractor shall also submit a proposed method of erosion control on haul roads and borrow pits and a plan for disposal of waste materials. No work, other than clearing

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removal, shall be started until the proposed erosion and sedimentation control methods have been accepted and approved. Clearing and tree removal, prior to receipt of the Contractor's Schedule of Work will only be allowed providing the Contractor's method of operation does not establish a source of water pollution or cause the soil to erode.

- (b) Erosion Control. The Engineer shall have the authority to limit the surface area of erodible earth material exposed by construction operations and to direct the Contractor to immediately provide permanent or temporary erosion control measures such as seeding, sodding, mulching and placing erosion control blankets. Such work may also include the construction of temporary berms, dikes, dams, sediment basins, slope drains and use of temporary mulches, mats, seeding or other control devices or methods as necessary to control erosion.

Cut slopes shall be fine graded, loamed if required and mulched as the excavation proceeds. Berm ditches shall be constructed prior to excavating for the cut. Between the dates of September 1 and May 1st, loam or seed will not be required. If construction continues during freezing weather, the slopes shall be continuously graded before freezing and the surface temporarily protected from erosion by the application of mulch. Cut slopes shall not be left exposed over the winter, or any other extended time of work suspension, unless treated in the above manner.

Uncompleted fill slopes shall be kept in a smooth condition and the surface temporarily protected with mulch. Fill slopes shall not be left unprotected over the winter or during other periods of work suspension.

Until such time as the permanent treatment is established in ditches, erosion shall be controlled by the installation of hay bale erosion checks in accordance with the standard detail for temporary ditch protection, or by other approved measures.

The Contractor shall incorporate permanent erosion control features into the project at the earliest practicable time as shown in the Schedule of Work. Temporary erosion control measures shall be used to control erosion during construction prior to the establishment of permanent control features on the project.

Where erosion is likely, clearing and grubbing operations shall be scheduled and performed so that grading operations and temporary and permanent erosion control features can follow immediately thereafter. The Contractor shall limit excavation, borrow and embankment operations commensurate with his capability and progress

in keeping the finish grading, mulching, seeding and other such temporary and permanent erosion control measures current in accordance with the accepted schedule. Should seasonal limitations make such coordination impractical, temporary erosion control measures shall be provided immediately.

During periods of approved suspension, the Contractor will be required to correct and/or maintain the effectiveness of temporary and permanent erosion control features when directed by the Engineer.

- (c) Water Pollution. The Contractor shall exercise every reasonable precaution throughout the life of the contract to prevent pollution of rivers, streams, estuaries, coves, bays, lakes, ponds or other impoundments as well as tidal marshlands. Pollutants, except as allowed by approved permit, such as residue from cleaning and/or painting of bridge material, from removal of existing bridges, cement mixtures, chemicals, fuels, lubricants, bitumens, raw sewage, wood chips and other harmful waste shall not be discharged into or alongside of rivers, streams, estuaries, coves, bays, lakes, ponds or other impoundments as well as tidal marshlands or into natural or man-made channels leading thereto. The Contractor shall also comply with the applicable Federal and State Laws and regulations and other statutes relating to prevention and abatement of pollution.

Such operations as removing borrow, washing aggregates, constructing embankments under water, disposing of waste or surplus material as specified in Subsection 203.06, disposing, of oil, bitumens, wood chips or chemicals may result in violation of the water pollution laws.

Unless otherwise approved in writing, construction operations in rivers, streams, estuaries, coves, bays, lakes, ponds or other impoundments, as well as tidal marshlands, wetlands and other aquatic ecosystems and surface waters shall be restricted to the construction limits shown on the plans and to those areas which must be entered for the construction of temporary or permanent structures.

Upon completion of the work; rivers, streams, estuaries, coves, bays, lakes, ponds or other impoundments, as well as tidal marshlands, wetlands and other aquatic ecosystems and surface waters shall be promptly cleared of all falsework, piling, debris or other obstructions caused by the construction operations.

Excavated material shall not be deposited in or so near to rivers, streams, estuaries, coves, bays, lakes, ponds

or other impoundments as well as tidal marshlands,
wetlands and other aquatic ecosystems and surface waters

and flood plains, that it will be washed away by high water or runoff.

Unless otherwise approved in writing, mechanized equipment shall not be operated in streams except as may be allowed by approved permit and required to construct channel changes and temporary or permanent structures.

- (d) Method of Measurement and Basis of Payment. Required temporary erosion and pollution control work, which is not attributed to the Contractor's negligence, carelessness or failure to install permanent controls, shall be performed as ordered and will be paid for under the appropriate contract item. Necessary grading, unless performed under some other item, will be paid for under Section 631, Equipment Rental. Should the work not be comparable to the project work under the applicable contract items, the Contractor shall perform the work on a force account basis or by agreed unit prices in accordance with Subsection 109.04.

Work necessary to correct or maintain erosion control during suspended periods shall be paid for under the force account provisions of Subsection 109.04.

SECTION 108 -- PROSECUTION AND PROGRESS

108.01 Subletting of Contract. The Contractor shall not sublet, sell, transfer, assign or otherwise dispose of the contract or contracts or any portion thereof or of the right, title or interest therein, without written request to and written approval of the Department. No work shall be started by the Subcontractor until the "Request for Subcontract Approval" has been approved by the Engineer.

Requests for permission to sublet, assign or otherwise dispose of any portion of the contract shall be in writing and if requested, accompanied by an assurance that the organization which will perform the work is experienced and equipped to do the work. The Contractor shall give assurance that the minimum wage for labor, as stated in his proposal, shall apply to labor performed on all work sublet, assigned or otherwise disposed of in any way. If consent is given, the Contractor will be permitted to sublet a portion thereof, but shall perform with his own organization, work amounting to not less than 50 percent of the total contract cost, not including the percent goal required in the contract proposal to be done by a Disadvantaged/Women Business Enterprise. Items designated in the contract by the Department as Specialty Items may be performed by subcontract, and the cost of any such Specialty Items so performed by

subcontract may be deducted from the total cost before computing the amount of work required to be performed by the Contractor with his own organization.

Upon receipt of evidence that a subcontractor is not performing in a satisfactory manner the Department may by a letter to the Contractor, withdraw its approval of a Subcontractor. The Contractor upon receipt thereof shall discharge the Subcontractor from all further work. It is agreed between the parties to the contract that such action shall not constitute a breach of contract.

The Contractor shall file, with the Department, copies of all sublet assignments and, if requested by the Department, furnish copies of sublet agreements. No subcontract or transfer of contract, shall in any case relieve the Contractor of his liability under the contract.

All subcontracts shall contain, by inclusion or reference, all pertinent provisions of the contract and will be subject to requirements thereof.

The Contractor may, for purposes of this requirement, omit, remove or obscure the prices shown in the copy of the subcontract submitted to the Department.

A subcontracting arrangement shall be considered to exist when a person or firm assumes obligation for performing part of the contract work, using their own equipment and workmen, procuring their own materials and supplies exclusive of contract pay items such as Structural Steel Delivered and furnishing their own supervision with only general overall supervision being exercised by the prime Contractor, approved subcontractor or lower tier Subcontractor.

The prime Contractor shall not carry the workmen of another recognized Contractor on the prime Subcontractor's or an approved Subcontractor's payroll.

108.02 Notice to Commence Work. The notice to commence work will give the date on which the Contractor must begin construction and from which contract time will be charged. Commencement of work by the Contractor prior to receipt of said notice shall constitute a waiver on his part of this notice. The Contractor shall not begin work prior to the date of signing of the contract agreement by the Commissioner.

108.03 Prosecution of Work. The Contractor shall begin work as set forth in the Schedule of Work, specified in Subsection 105.051. The Engineer reserves the right to request a revised Schedule of Work at any time.

If, during the work by the Contractor the Engineer determines that satisfactory progress is not being made to enable completion of the project within the time specified in the contract, the Engineer will order the Contractor, in writing, to increase his forces, machinery and equipment or otherwise increase his effort to a level satisfactory and without additional expense to the Department. The Contractor shall immediately comply with this

order or reply to the Engineer in writing all reasons why the Contractor cannot comply therewith. In the event of reply by the Contractor, the Engineer will provide a written response to the Contractor's reply. None of the foregoing provisions shall relieve the Contractor of his obligation to complete the work within the time specified. The Contractor shall not suspend any portion of the work without a written order from the Engineer. Should the work for any reason be discontinued with the written approval of the Department, either the Contractor or the Department shall provide 24 hour advance written notice prior to resuming the work.

108.04 Limitation of Operations. The Contractor shall conduct the work at all times in a manner and sequence to assure the least interference with traffic. He shall have due regard to the location of detours and to the provisions for handling traffic. He shall not open up work to the prejudice or detriment of work already started. The Engineer may require the Contractor to finish a section on which work is in progress before work is started on any additional sections if finishing such section is essential to public convenience.

Unless otherwise specified, the Contractor shall not carry on construction operations on Sundays or Holidays, unless of an emergency nature. The Contractor may work on Martin Luther King Day, Washington's Birthday, Patriots Day and Columbus Day without first obtaining permission of the Engineer of Construction. Permission to work on Sundays and other Holidays must be obtained prior to the Sunday or Holiday. In addition, if so directed, the Contractor shall suspend all work, other than maintaining the roadway for traffic, on all portions of the project open to traffic, at such other times as the Engineer deems necessary. Working days or calendar days will not be charged against the Contractor during any such suspension period.

108.05 Character of Workmen, Methods and Equipment. The Contractor shall at all times employ sufficient superintendents, foremen, labor and equipment for prosecuting the work in the manner and time required by the contract.

All workers shall have sufficient skill and experience to properly perform the work assigned them.

Any person employed by the Contractor or by any Subcontractor or any officer or representative or agent of the Subcontractor who, in the opinion of the Engineer, does not perform the work in a proper and skillful manner or is intemperate or disorderly, shall be removed immediately by the Contractor or subcontractor

employing such person and the employee shall not be employed again in any portion of the work without approval.

Should the Contractor fail to remove such person or persons as required above or fail to furnish suitable and sufficient personnel for the proper prosecution of the work, the Engineer may suspend the work by written notice until such orders are complied with.

All equipment used on the work shall be of sufficient size and in such mechanical condition as to meet requirements of the work to produce satisfactory quality work and meet all safety requirements. Equipment used on the project shall not cause injury to the roadway, adjacent property or other highways.

When the methods and equipment to be used by the Contractor are not prescribed in the contract, the Contractor may use any reasonable methods or equipment that will accomplish the work in accordance with the contract.

When the contract specifies that the construction be performed by certain methods and equipment, those methods and the equipment shall be used unless others are authorized. If the Contractor wishes to use a method or equipment other than those specified, he shall request permission to do so in writing and include a full description of the methods and equipment to be used, an explanation of the reasons for making the change and an estimate of savings or added cost, if any, to the Department. If written approval is given, the Contractor shall perform the work in conformity with the contract. If, after trial use the Engineer determines that the work produced does not comply with the contract, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the work with the specified methods and equipment. The Contractor shall at his own expense remove all deficient work and replace it with work of specified quality or take such other corrective action as may be directed. No change will be made in the basis of payment or in contract time as a result of any change in methods or equipment under this Subsection.

108.06 Determination and Extension of Contract Time. The number of working days, calendar days or the specified completion of the work will be provided in the proposal and will be known as the contract time.

When the contract time is on a working day basis, the time charge shall begin on the earliest of the following:

- (a) The date any work is performed on a pay item or,
- (b) The date specified in the "Notice to Commence work under Subsection 108.02.

When the contract time is on a working day basis and work has been suspended during the winter months, the time charge will resume on the first working day after May 15th. If because of ground or weather conditions the Contractor is unable to work, a working day will not be charged against the project until the

Engineer determines that the conditions have changed sufficiently for the Contractor to resume work.

When the contract is on a calendar day basis, the time charge shall begin on the earliest of the following:

- (a) The date any work is performed on a pay item or,
- (b) The date specified in the Notice to Commence work under Subsection 108.02.

All calendar days elapsed between the effective dates of any orders to suspend work and to resume work after suspensions, not the fault of the Contractor, shall be excluded.

When the contract time is on a working day or calendar day basis, the Engineer will furnish the Contractor a written weekly report showing the number of days charged to the contract for the preceding week, the number of days specified for completion of the contract and the number of days remaining to complete the contract. The Contractor will be allowed one week in which to file a written protest setting forth in what respects said weekly statement is incorrect, otherwise the statement shall be deemed to have been accepted by the Contractor as correct.

When the contract time is based on a specified completion date, all work on the project shall be complete on that date.

If the Contractor cannot complete the work within the contract time specified for reasons beyond his control, he may make at any time prior to the expiration of the contract time, a written request to the Department for an extension of time, setting forth reasons supporting the request. The Contractor's plea that insufficient time was specified is not a valid reason for extension of time. If the Department finds that the work was delayed because of conditions beyond the control and without the fault of the Contractor, the Department may at its discretion extend the time for completion of the project in an amount as the conditions justify. The extended time for completion shall thereafter be considered as though it was the original time for completion.

In the event the Contractor cannot complete the work within the contract time for any other reason, the Department may at its discretion provide the Contractor with an extension of time in writing. The Contractor shall comply with all departmental conditions required for such extension.

When the Engineer has made final acceptance of the work as prescribed in Subsection 105.17, the time charge will cease.

108.07 Suspension of Work. The Engineer may suspend the work in whole or in part by written order to the Contractor, for any period due to unsuitable weather, conditions considered unfavorable by the Engineer for the prosecution of the work, failure of the Contractor to correct conditions unsafe for workmen or the general public or failure to carry out written

orders of the Engineer on the project, violation of any material provisions of the contract given or for any other reason or condition which would be in the best interest of the Department.

If it should become necessary to suspend work for an indefinite period, the Contractor shall store all materials so they will not obstruct or impede the traveling public, nor become damaged in any way. He shall take all precautions to prevent damage or deterioration of the work already performed, provide suitable drainage of the roadway by opening ditches, shoulder drains and erect temporary structures where necessary.

Before suspension of work for the winter, Guardrail items shall be installed where directed by the Engineer. The cost of any subsequent removal and resetting or adjusting of such Guardrail shall be considered incidental to the Guardrail items and no additional payment will be made except as provided in Subsection 104.044.

108.08 Failure to Complete on Time. For each work day or calendar day that any work remains uncompleted after the contract time specified for the completion of the work, the amount per working day or calendar day, specified in the contract shall be deducted from any money due the Contractor, not as a penalty but as liquidated damages; provided, however, that due account shall be taken of any adjustment of the contract time for completion of the work granted under the provisions of Subsection 108.06. If such charges exceed the sum which would have been payable under the contract the Contractor and the Surety shall be liable and shall pay the Department the amount of such excess.

For a specified completion date contract time, liquidated damages will be determined according to the calendar day basis.

Payment of liquidated damages will be by deductions from payments otherwise due from Department to Contractor or by direct payment by the Contractor in the event the total liquidated damages due hereunder exceed said deductions.

108.09 Schedule of Liquidated Damages. The specific rates for liquidated damages will be set forth in the Special Provisions.

108.10 Default of Contract. If the Contractor:

- (a) Fails to begin the work under contract within the time specified in the Notice to Proceed or

- (b) Fails to perform the work with sufficient workmen and equipment or with sufficient materials to assure the prompt completion of said work or
- (c) Performs the work unsuitably or neglects or refuses to remove materials or to perform anew such work as may be rejected as unacceptable and unsuitable or
- (d) Discontinues the prosecution of the work or
- (e) Fails to resume work which has been discontinued within a reasonable time after notice to do so, or
- (f) Becomes insolvent or is declared bankrupt or commits any act of bankruptcy or insolvency or
- (g) Allows any final judgment to stand against him unsatisfied for a period of 10 days or
- (h) Makes an assignment for the benefit of creditors without authorization by the Department or
- (i) For any other cause whatsoever, fails to carry on the work in manner acceptable to the Department, the Engineer will give notice in writing to the Contractor and his Surety of such delay, neglect or default.

If the Contractor or Surety, within a period of 10 days after such notice, does not proceed in accordance therewith, then the Commissioner will, upon written notification of the fact of such delay, neglect or default and the Contractor's failure to comply with such notice, have full power and authority without violating the contract, to take prosecution of the work away from the Contractor. The Department may use any or all materials and equipment as may be suitable and may enter into an agreement for the completion of said contract according to the terms and provisions thereof or use such other methods as in the opinion of the Engineer will be required for the completion of the contract in an acceptable manner.

All costs and charges incurred by the Department, together with the cost of completing the work done under the contract, will be deducted from monies due or which may become due the Contractor. If such expense exceeds the sum which would have been payable under the contract, the Contractor and the Surety shall be liable and shall pay to the Department the amount of such excess.

108.11 Termination of Contract. The Department may, by written order to the Contractor, terminate the contract or any portion thereof when such termination would be in the best interest of the Department. In the event such termination occurs without fault and for reasons beyond the control of the Contractor, all completed items of work as of the date of termination will be paid for at the contract bid price. Payment for partially completed work will be made either at agreed prices

or by force account methods provided in the contract. Items which are eliminated in their entirety by such termination shall be paid for as provided in Subsection 109.05. Contractor shall make all work records available to the Department upon request regarding payment under this Subsection.

Acceptable materials, obtained by the Contractor for the work but which have not been incorporated therein, may, at the option of the Department, be purchased from the Contractor at actual cost delivered to a prescribed location or otherwise disposed of as mutually agreed.

After receipt of Notice of Termination from the Department, the Contractor shall submit, within 60 days of the effective termination date, his claim for additional damages or costs not covered above or elsewhere in these Specifications. Such claim may include such cost items as idle equipment time, bidding and project investigative costs, overhead expenses attributable to the project terminated, legal and accounting charges involved in claim preparation, subcontractor costs not otherwise paid for, 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 figure be reached with the Contractor. In no event, however, will loss of anticipated profits be considered as part of any settlement.

The Contractor agrees to make his cost records available to the extent necessary to determine the validity and amount of each item claimed.

Termination of a contract or portion thereof shall not relieve the Contractor of his contractual responsibilities for the work completed, nor shall it relieve the Surety of its obligation for and concerning any just claim arising out of the work performed.

SECTION 109 -- MEASUREMENT AND PAYMENT

109.01 Measurement of Quantities. All work acceptably completed under the contract will be measured according to International System of Measurements (SI) {United States} customary units.

For all items, other than those to be paid for by lump sum, after the work is completed and before final payment is made, the Engineer shall determine the quantities of various items of work accepted as the basis for final payment. In case of unit price items the Contractor will be paid the amount for the quantity of work accepted and for the materials placed. The quantities of work performed shall be computed in accordance with the methods of measurements specified under the item involved.

The distance between stations when used as a definition or term of measurement will be 1 km {100 linear feet} when using the International System of Measurements or 100 feet if using United States customary units.

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

Unless otherwise specified, longitudinal measurement for surface area computations will be made horizontally and no deduction will be made for individual fixtures having a surface area of 1 m² {9 square feet} or less. Unless otherwise specified, transverse measurements for area computations will be the neat dimensions shown on the plans or as ordered.

Structures will be measured according to neat line as shown on the plans or as altered for field conditions in accordance with the method of measurement stated in the specifications.

All items which are measured by the meter {linear foot} will be measured parallel to the base or foundation upon which such structures are placed, unless otherwise shown on the plans or in the special provisions.

In computing volumes of excavation, the average end area method or other acceptable methods will be used.

The term "gauge", when used in connection with the measurement of plates, will mean the US Standard Gauge.

Except for electrical application, the term "gauge" referring to the measurement of wire shall mean the wire size number specified in AASHTO M32. When used in electrical applications the term "gauge" will mean the American Wire Gauge (AWG).

The term "ton" when using English units shall mean 2,000 pounds avoirdupois.

The term megagram when using metric units shall mean 1000 kilograms.

The term "barrel" will mean 170.55 kg {376 pounds} of cement.

When using metric units, timber will be measured by the cubic meter based on actual measurements of the timber incorporated in the structure. When using English units, timber will be measured by the thousand feet board measure (MFBM) actually incorporated in the structure with the measurements based on nominal widths and thicknesses and the extreme length of each piece.

The term "lump sum" when used as an item of payment will mean complete payment for the work specified in the contract.

When a complete structure or structural unit is specified as the unit of measurement, the lump sum unit will include all necessary fittings and accessories unless otherwise specified.

When standard manufactured items such as fence, wire, plates, rolled shapes, pipe conduit or others are identified by gauge, unit weight or section dimensions, such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved

will be accepted.

All materials which are measured or proportioned by weight shall be weighed on approved scales. When a delivery slip is required for payment of materials measured by weight, weighing, except for automatic ticket printer systems, shall be performed on approved platform truck scales by a Licensed Public Weighmaster furnished by the Contractor, in accordance with the following requirements.

- (a) Licensed Public Weighmaster. A Licensed Public Weighmaster shall be any person satisfying the requirements of the State Sealer of Weights and Measures and granted a license as a Public Weighmaster. Each Licensed Public Weighmaster shall provide himself with an impression seal as required by the State Sealer and shall impress this seal upon delivery slips issued by him. When completed by a Licensed Public Weighmaster, delivery slips shall be considered as the Weight Certificates required by the Maine Weights and Measures Law, MRSA Title 10. The Weighmaster shall perform all duties required of him by law and the specifications.
- (b) Weighing Trucks. Tare weights of trucks hauling stone, bituminous mixes and similar items shall be determined twice daily, once during the forenoon and once during the afternoon. The tare weight thus found shall be used to determine the net load until the next tare weighing of the empty truck. Tare weights of trucks hauling liquid and bituminous cement materials or other items not generally on a repeat basis shall be determined immediately before being loaded and the weight thus found shall be used for that load only. The tare weight of a truck shall be defined as the weight of the empty vehicle including the driver, but with no passengers.
- (c) Platform Truck Scales. An approved platform truck scale meeting the following requirements shall be provided, installed and maintained, when required, by the Contractor or be available to him at an approved nearby location:
 - 1. The scale shall conform to the specifications, tolerances and regulations for commercial weighing devices of the National Institute of Standards and Technology and shall be accurate within maximum tolerances of plus or minus 1 kg {2 pounds} per 500 kg {1,000 pounds} of load.
 - 2. No auxiliary indicators, in combination with the beams or dial of the scale shall be used to increase the maximum allowable load above 105 percent of the

manufacturer's rated capacity, as stated in the
National Institute of Standards and Technology
Handbook 44 S.1.7.

3. The platform of the scale shall be of sufficient size to accommodate the entire vehicle or combination of vehicles. If a combination of vehicles must be divided into separate units in order to be weighed, each unit shall be entirely disconnected before weighing and a separate weight certificate, delivery slip or ticket shall be issued for each separate unit.
 4. The value of the minimum graduation on the indicator of the scale shall not be greater than 10 kg {20 pounds}. All weighing shall be read and recorded to the nearest 10 kg {20 pounds or one-hundredth ton}.
 5. The scale shall be set on concrete or other approved foundation. The recording mechanism of the scale shall be suitably housed or protected from weather.
 6. The Contractor shall have the scale inspected and approved by the State Sealer of Weights and Measures or by a Repairman registered and approved by the State Sealer within a period of 12 months preceding the date of any weighing and again after each change of location.
- (d) Check Weighing for Platform Truck Scales. Check weighing shall be made on the weights and on the weighing-in scales during production in the following manner:
1. At least once each day, in the presence of a State Inspector, a loaded truck which has been weighed and issued a weight slip shall be turned and a new weighing made of the truck and load with the truck heading in reverse direction and at the opposite end of the scale platform from the first weighing. The new weight will be recorded. If the variation from the first weight is 0.2 of 1 percent or less, the fact will be so noted in the project records. However, if the variation exceeds 0.2 of 1 percent, the scales may not be used until rechecked and resealed by the State Sealer of Weights and Measures.
 2. At least once each day, a loaded truck which has moved off the scales will be intercepted, directed back to the scales and reweighed under supervision of a State Inspector.
 3. At least once each day, in the presence of a State Inspector, a truck which has been emptied will be directed to the scales before being loaded at a time other than the normal tare weighing and weighed again for a check on the tare weight.
 4. Check weighing will be on a plant basis and, although a plant may produce material for more than one

project or contract, check weighing will not be required for each project or contract.

5. Although a minimum of one check weighing a day is specified, additional checks will be made occasionally at the discretion of the Engineer. Claims by the Contractor for delays or inconvenience due to check weighing will not be considered.

(e) Reciprocal Agreements. Weighing of materials on scales located outside the State of Maine will be permitted for materials produced or stored outside the State, when requested by the Contractor and approved. Out-of-State weighing, in order to be approved, must be performed by a Licensed Public Weighmaster or a person of equal authority in the State concerned, on scales accepted in the State concerned and meeting the requirements given in subparagraph 109.01(c).

(f) Delivery Slips. Serially prenumbered delivery slips of acceptable size and format for stating the following minimum information shall be furnished by the Contractor, in as many copies as may be necessary. One copy shall be signed and retained by the Engineer or his inspector upon accepting delivery of the material.

1. Vehicle Identification

2. Date loaded.

3. Project number.

4. Identification of material:

- a. Source location of supplier,

- b. Type and grade,

- c. Tank number from which loaded, if liquid:

5. Quality information as necessary for bituminous liquids.

- a. Specific gravity at 15°C {60°F}

- b. Serial number of the Certificate of Analysis as furnished according to Division 700, General Statement,

- c. The Certificate Statement as required in Division 700, General Statement,

- d. The Viscosity of the material: If asphalt cement, in poises at 60°C {140°F} and in centistokes at 135°C {275°F}; if other bituminous liquid, the specified viscosity according to the type and grade shown in Section 702.

6. Quantity information as necessary: Gross, Tare and Net Weights, Volume of Load if not material requiring weighing, net liters {gallons} at 15°C {60°F} if

bituminous liquids.

7. Signatures (legible initials acceptable) of:
Weighmaster (if weight measured material),
Contractor's representative (if volume measured material), and State Inspector.

If materials are shipped by rail the car weight may be accepted provided that only the actual weight of material is paid for. However, car weights will not be acceptable for materials to be passed through mixing plants. Trucks used to haul material being paid for by weight shall be weighed empty, daily, at such times as directed. Each truck shall bear a legible identification mark.

Rail shipments of bituminous liquid shall be measured directly by volume. Correction shall be made when liquid bituminous material has been lost from the car, wasted or otherwise not incorporated in the work. Other shipments of bituminous liquids will be measured by the liter {gallon} or megagram {ton}. Volumes will be measured at 15°C {60°F} or will be corrected to the volume at 15°C {60°F} using the tables in ASTM D1250.

When bituminous liquids are shipped by truck or transport, net certified weights or volume subject to correction for loss or foaming may be used for computing quantities. Net certified weight shall be determined upon loading for all bituminous liquids when shipped by truck or transport. The net weight of each load shall be converted to net liters {gallons} at 15°C {60°F} by a conversion factor expressed in kilograms per liter {pounds per gallon}.

109.011 Determination of Conversion Factor. The supplier or producer of the bituminous liquids shall determine the specific gravity of each lot of each type and grade of liquid furnished according to the most recent AASHTO method, corrected to 15°C {60°F}. If using metric units, the conversion factor shall be determined by multiplying the specific gravity by 0.999; the weight in kg of 1 L of water at 15°C {60°F} to the nearest 0.005 kg/L. The conversion factor in kg per liter shall be entered upon all loading invoices for each bituminous liquid. If using English units, the conversion factor shall be determined by multiplying the specific gravity by 8.334; the weight in pounds of one gallon of water at 15°C {60°F} to the nearest one-hundredth pound per gallon. The conversion factor in pounds per gallon shall be entered upon all loading invoices for each bituminous liquid.

Upon delivery, the net liters {gallons} measured when loaded shall be subject to correction when bituminous liquid has been

lost from the vehicle, wasted or otherwise not incorporated in the work. Correction, when required at a location other than the point of loading and weighing, will be determined by volume measurement, using a calibrated tank gauge, measuring stick or other acceptable measurement. Measurement shall be reconciled with the Contractor

1-113or when performed and shall
be final.

109.012 Automatic Ticket Printer System on Automatic Bituminous Mixing Plant. An approved automatic ticket printer system shall be used with all approved automatic bituminous mixing plants, the requirements for delivery slips for payment of materials measured by weight, as given in the following Subsections, shall be waived: 109.01(a), 109.01(b), 109.01(c), 109.01(d). The automatic printed ticket will be considered as the Weight Certificate.

The requirements of 109.01(f) shall be met by the weigh slip or ticket, printed by the automatic system, which accompanies each truck load, except for the following changes:

- (a) The quantity information required shall be individual weights of each batch or total net weight of each truck load.
- (b) Signatures (legible initials acceptable) of Weighmaster (required only in the event of a malfunction below), State Inspector.

Automatic bituminous mixing plants shall have the scales sealed by the State Sealer of Weights and Measures within a period of 12 months preceding the date of any weighing and after each change of location. The Contractor shall make checks on the accuracy and sensitivity of the aggregate and asphalt plant scales as specified in Subsection 401.082(e), in the presence of a representative of the State, at intervals not exceeding 60 days.

Weekly sensitivity checks will be made on all scales.

109.013 Weight Checks on Automatic Bituminous Mixing Plant. At least twice during each 5 days of production either of the following checks will be performed:

- (a) A loaded truck may be intercepted and weighed on a platform scale that has been sealed by the State Sealer of Weights and Measures within the past 12 months. Whenever the discrepancy in net weights is greater than 1.0 percent, but does not exceed 1.5 percent, the plant

inspector will notify the producer to take corrective action; payment will still be governed by the printed ticket. The producer will be allowed a period of two days to make any needed repairs to the plant and/or platform scales so that the discrepancy in net weights between the two is less than 1.0 percent. If the discrepancy exceeds 1.5 percent, the plant will be allowed to operate as long as payment is determined by truck platform scale net weight. Effective corrective action shall be taken within two working days.

- (b) Where platform scales are not readily available, a check will be made to verify the accuracy and sensitivity

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115of each scale within the normal weighing

range and to assure that the interlocking devices and automatic printer system are functioning properly.

- (c) In the event of a malfunction of the automatic printer system, production may be continued without the use of platform truck scales for a period not to exceed the next 2 working days, providing total weights of each batch are recorded on weight tickets and certified by a Licensed Public Weighmaster.

109.02 Scope of Payment. Payments to the Contractor shall be full compensation for furnishing all materials and for performing all work under the contract in a complete and acceptable manner and for all risk, loss, damage or expense of whatever character arising out of the nature of the work or the prosecution thereof, subject to the provisions of Subsection 107.22.

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

109.03 Compensation for Altered Quantities. When the accepted quantities of work vary from the quantities in the bid schedule, the Contractor shall accept as payment in full, so far as contract items are concerned, payment at original contract unit prices for the accepted quantities of work, unless an appeal has been filed under the procedure and protest clause of Subsection 105. No allowance, except as provided in Subsection 104.02, 104.03, 108.07 and 108.11, will be made for:

- a. Any increase in cost.
- b. Loss of expected reimbursement.
- c. Loss of anticipated profits.
- d. Loss from unbalanced allocation of overhead expense.

109.04 Differing Site Conditions, Changes, Extra Work and Force Account Work (Revised). Differing site conditions, changes, and extra work performed in accordance with the requirements and provisions of Subsection 104.03 will be paid for using the following methods as appropriate:

- (a) Contract unit prices.
- (b) Unit prices agree upon in the order authorizing the work.
- (c) An agreed upon lump sum amount.
- (d) If directed by the Department, on a force account basis to be compensated in the following manner:

1. Labor. When the items "Hand Labor" and "Foreman" are not called for in the proposal, the following shall apply: for all labor and foremen in direct charge of the specific operations, the Contractor shall receive the actual hourly rate of wage paid to each worker and foreman actually engaged in the work. To the labor costs shall be added an amount equal to 90 percent of the sum thereof; which added amount shall constitute payment for all bond and insurance premiums and taxes paid by the Contractor for property damage, liability and workmen's compensation insurance premiums, unemployment insurance contributions, social security taxes and other overhead and profit on the force account work.
2. Materials. For all materials used and incorporated in the permanent work, the Contractor shall receive the actual cost of such materials, freight and delivery charges, as shown by the original receipted bills, plus 15 percent of such costs not including State sales tax. For all materials not incorporated in the permanent work, the Contractor shall receive actual value of such material at the time of its use less the fair salvage value of material when released. Upon the sum thus determined an allowance of 15 percent will be made to the Contractor.
3. Equipment. For all power operated machinery or other equipment, including trucks, the use of which has been authorized, the Contractor shall receive the rental rates for the actual time to the nearest $\frac{1}{4}$ hour that such equipment is in operation on the work. Time spent moving to and from the site within the project limits and any approved idle time may be measured for payment when authorized. Time spent servicing, maintaining, and changing attachments will not be measured for payment. The rental rates shall include the cost of all fuel oil, lubrication, supplies, necessary attachments, repairs and maintenance of any kind, depreciation, storage, insurance, small tools and all other incidentals. The rental rates will be determined from the rates published by Dataquest, Inc., for such equipment listed in the current edition of the "Rental Rate Blue Book for Construction Equipment" or "Rental Rate Blue Book for Older Construction Equipment", hereafter called the Blue Book, when the work is being performed and as hereafter specified.
The hourly equipment rental rate (R) will be determined by the following formula:
$$R = A \times B \times E + C + D$$

A = Blue Book monthly rate divided by 176
B = Blue Book regional adjustment factor for Maine
C = Blue Book estimated operating costs per hour
D = Operator's hourly payroll rate plus 90 percent
E = Factor from the Rate Adjustment Table for the year the machine was made

When the Contractor's equipment is ordered to be available for force account work, but is idle for reasons not the fault of the Contractor, standby time will be paid at 50 percent of the hourly equipment rental rate excluding all operating costs. For equipment leased by the Contractor for force account work, payment will be made for the actual invoice cost with no additional markup.

For each piece of equipment, the Contractor shall provide the Engineer with the following information: the manufacturer's name, equipment type, year of manufacture, model number, type of fuel used, horsepower rating, attachments required, together with their size or capacity and any further information necessary to ascertain the proper rate.

Unless otherwise specified, manufacturer's ratings and manufacturer-approved modifications shall be used to classify equipment for the determination of applicable rental rates. Equipment which has no direct power unit shall be powered by a unit of at least the minimum rating recommended by the manufacturer.

If it is deemed necessary by the Engineer to use equipment not listed in the above publication, a suitable rate for such equipment will be established by the Engineer. The Contractor may furnish cost data which might assist the Engineer in the establishment of such rental rate.

4. Superintendence. No part of the salary or expense of anyone connected with the Contractor's forces above the grade of foreman and having general supervision of the work, will be included in the labor items as specified above, except when the Contractor's organization is entirely occupied with force account work, in which case, the salaries of the superintendent and the timekeeper may be included in the labor item specified above when the nature of the work is such that their services are required.
5. Compensation. The compensation as set forth above shall be received by the Contractor as payment in full for extra work done on a force account basis.
6. Statements. All statements shall be accompanied and

supported by receipted invoices for all materials used and transportation charges. If materials used on the force account work are not specifically purchased for such work but are taken from the Contractor's stock, then instead of invoices, the statements shall contain or be accompanied by an affidavit of the Contractor certifying that such materials were taken from stock, that the quantity claimed was actually used and that the price and transportation claimed represent the actual cost to the Contractor. No payment will be made for work performed on a force account basis until the Contractor has furnished duplicate itemized statements of the cost of such force account work detailed to the following:

Name, classification, date, daily hours, total hours, rate and amount for each foreman and laborer.

Designation, dates, daily hours, total hours, rental rate and amount for each unit of equipment.

Quantities of materials, prices and amounts.

Transportation charges on materials.

7. Specialty Work. When specialty work is considered necessary for the satisfactory completion of the project for which there is no contract price and the type of work involved requires specially trained men and special equipment, the Contractor may engage an approved concern or personnel to do this work.

Payment for acceptably completed specialty work will be made on the basis of the total cost of the work, supported by a receipted invoice in duplicate, made out to the Contractor from the concern actually performing the work.

Total cost of the work shall mean the cost of all labor, materials, equipment, tools, insurances, taxes and any other authorized costs necessary to complete the work.

To the sum thus determined an amount of 15 percent will be allowed the Contractor.

109.05 Eliminated Items. Should any items contained in the proposal be found unnecessary for the completion of the work, the Engineer may, upon written notification to the Contractor, eliminate such items from the contract and such action shall not invalidate the contract. No allowance will be made for anticipated profits for items eliminated in making final payment to the Contractor. When a Contractor is notified of the elimination of items, he will be reimbursed for actual work done and costs incurred in partial performance of the eliminated items, as shown on bills submitted by the Contractor, including mobilization of materials prior to notification.

109.06 Adjustments for Changes in Common Carrier Rates. It is understood and agreed that the accepted proposal for this project

is based on common carrier rates on file with the Interstate Commerce Commission or with a corresponding intrastate commission or body and in effect on the day of opening bids. Payments to the Contractor will be adjusted to compensate for increases and decreases in cost due to changes in common carrier rates becoming effective after the date of opening bids and before the date specified for completion of the work, as adjusted because of authorized extensions of time.

The adjustments shall be the product of the net increases or decreases in the said common carrier rates, multiplied by the net quantity of material shipped at the new rates to the work and incorporated in the work, all as shown by the receipted common carrier bills.

109.07 Partial Payments. Partial payments will be made at least once each month as the work progresses. Estimates may be paid twice each month if in the judgment of the Engineer the amount of work performed is sufficient to warrant such payment. Payment will be based upon estimates, prepared by the Engineer, of the value of the work and materials complete in place and accepted in accordance with the contract and in accordance with Subsections 109.08 and 109.09, for materials delivered. All materials estimates and payments shall be subject to correction in subsequent partial estimates and payments and on the final estimate and payment. No such estimate or payment shall be made when, in the judgment of the Engineer, the work is not proceeding in accordance with the provisions of the contract or when the total value of the work done since the last estimate amounts to less than 5,000.00 dollars.

Except as provided in Subsection 107.15, the amount for payment shown on each progress estimate will be paid in full until 50 percent of the contract amount has been paid, after which 5 percent of each subsequent progress payment will be deducted and retained until completion of the work.

Retained funds will be withheld and disbursed by the Department in accordance with 23 M.R.S.A. Sec. 52-A.

Upon completion of the work under this contract, the Engineer may release 100 percent of the amount then retained. The balance of the amount retained will be held until all reports required of the Contractor are received and final payment is authorized by the Commissioner. The Commissioner, at his option, may retain temporarily or permanently, from time to time, such portion of the amount retained as he deems equitable.

109.08 Payment for Material Delivered on the Project. At the discretion of the Engineer, acting upon a request from the Contractor and accompanied by receipted bills, payment may be made for all or part of the value of acceptable, non-perishable materials which are to be incorporated in the work; such as stone

masonry, curbing, timber and lumber, metal culverts, stone and sand, gravel and other materials delivered on the work or in the vicinity of the work at acceptable storage places and not used at the time. Materials paid for by the Department shall become the property of the Department and in the event of default on the part of the Contractor the Department may use or cause to be used, these materials in the construction of the work provided for in the contract. The Contractor shall be responsible for any damage to or loss of these materials.

The payment for certain materials shall be determined as follows:

- (a) Borrow and unprocessed aggregates: 50 percent of the unit price.
- (b) Processed aggregates, except stone: when stockpiled in the pit, 30 percent of the unit price; when stockpiled on the project, 60 percent of the unit price.
- (c) Processed stone: when stockpiled in the quarry, 45 percent of the unit price; when stockpiled on the project, 55 percent of the unit price.
- (d) Loam stockpiled: 25 percent of the unit price.
- (e) Payment for all other materials shall be made as previously specified.

The amount thus paid by the Department shall be credited to reduce estimated amounts due the Contractor as the material is used in the work.

Partial payments for materials stockpiled will not constitute acceptance and all faulty material will be rejected even though previous payment may have been made.

No allowance for partial payment shall be made upon fuels, supplies, form lumber, falsework or other materials or on temporary structures of any kind which are not in the contract as a pay item or covered by the provisions of Subsection 109.04.

No payment will be made on living or perishable plant materials unless acceptably planted in their final locations.

109.09 Payment for Materials Not Delivered on the Project. At the discretion of the Engineer and acting upon a request from the Contractor, an estimate accompanied by the receipted bills, may be made for payment for all or part of the value of acceptable nonperishable material not delivered on the project, but stored in acceptable storage and not used at the time of such estimate. Payment for such materials shall be in accordance with Subsection 109.08. Payment will be in the amount indicated by receipted bills filed with the Department.

109.10 Acceptance and Final Payments. When the project has been accepted as provided in Subsection 105.17 the Engineer will prepare a final quantity estimate of the various classes of work performed. After approval of the final quantity estimate by the Contractor and after all supporting information necessary to substantiate pay quantities, including statements itemizing force account work, have been furnished by the Contractor, payment will be made in the amount of the work done after deducting all previous payments and all remaining amounts to be retained or deducted under the provisions of the contract.

Upon submission by the Contractor of all required reports, completed forms, certificates and a written statement that all bills for labor, equipment, material used under this contract have been paid, the payment of final estimate for the remaining amount retained may be paid. A written request for payment of the final estimate should accompany this statement but the failure of the Contractor to make a request for payment of the final estimate shall not prohibit making the final payment. The acceptance by the Contractor of the final payment shall constitute a release to the Department from all claims and liability under the contract. Upon termination of work and acceptance of the payment by the Contractor, the Contractor will then be released from further obligation, except as set forth in the contract bond.

All prior partial estimates and payment shall be subject to correction in the final estimate and payment.

109.11 Compensation For Project Delays. Strict compliance with the provisions of this Subsection will be an essential condition precedent to any equitable adjustment for delays.

- (a) Only the additional costs associated with the following items will be recoverable by the Contractor as an equitable adjustment for delay:
 - 1. Non-salaried labor expenses.
 - 2. Costs for materials.
 - 3. Equipment costs.
 - 4. Costs of extended job-site overhead.
 - 5. An additional 10 percent of the total of Items 1, 2, 3, and 4 for home office overhead and profit.
- (b) All costs claimed must be adequately documented when measuring additional equipment expenses (i.e., ownership expenses) arising as a direct result of a delay caused by the Department. Use of equipment rental rate guides shall not be used for this purpose. Use actual records

kept in the usual course of business, and measure increased ownership expenses pursuant to generally accepted accounting principles.

(c) The parties agree that, in any adjustment for delay costs, the Department will have no liability for the following items of damages or expense:

1. Profit in excess of that provided herein;
2. Loss of profit;
3. Labor inefficiencies;
4. Home office overhead in excess of that provided in subparagraph a;
5. Consequential damages, including but not limited to loss of bonding capacity, loss of bidding opportunities and insolvency;
6. Indirect costs or expenses of any nature;
7. Attorneys fees, claims preparation expenses, or costs of litigation.
8. Interest.

109.12 Asphalt Escalator Clause. A price adjustment for bituminous material is available for items paid under Divisions 300 and 400 excluding Section 425, Recycled Bituminous Pavement. Bituminous material used under other Divisions of the Specifications will not be included in this escalation clause. The price adjustment will be based on the variance in price for the asphalt cement component of hot bituminous mixes. This price adjustment is for the benefit of the Contractor to provide protection from catastrophic price increases in asphalt cement during the contract.

The Base Price for a ton of asphalt cement will be the Boston market price listed in the first issue of ENR Magazine the month the contract is awarded.

The Period Price of asphalt cement, for a two month period will be determined by the Department by averaging the listed Boston market price found in the first issue of each month in the ENR magazine, at the beginning, middle and end of each two month period. The year will be divided into six (6) two month periods beginning January 1st.

The price adjustment for asphalt cement will be made at the end of each two month period in which work was accomplished. The adjustment to cover the previous two months will be determined by the variance between the period price and the base price of asphalt cement.

The asphalt content of hot bituminous mixes for the purpose of this adjustment will be six percent for each ton of hot bituminous mix.

To qualify for a price adjustment, the contract shall include at least 9 000 Mg {10,000 tons} of hot bituminous mixes; contract completion shall be at least one year from date of advertisement; and the period price increases at least 10 percent over the base price.

A price adjustment will be considered upon request of the Contractor. The adjustment will be computed by multiplying the number of tons of hot bituminous mixes placed in the period by 0.06 times the variance in the period price in excess of 10 percent of the base prices. A price adjustment will not be applicable to hot bituminous mixes placed outside of the period under consideration.

It shall be understood that a price adjustment may affect the quantities of these items utilizing bituminous materials. An escalation may result in a decrease in the estimated quantities as determined by the Department. Should the average of the posted prices at any time exceed 135% of the base price, the Department reserves the right to cancel the remaining portions of those items utilizing bituminous materials.

DIVISION 200 -- EARTHWORK

SECTION 201 -- CLEARING RIGHT-OF-WAY

201.01 Description. This work shall consist of clear cutting, selective clearing and thinning, tree trimming, removing single trees, including dead, blown down or uprooted trees, removing and disposing of all stumps and debris within the limits of the right-of-way and easement areas except such objects as are designated to remain or are to be removed in accordance with other sections of these specifications. This work shall also include the preservation from injury to or defacement of all vegetation and objects designated to remain and the treatment of stumps with herbicides.

- (a) Clearing shall consist of cutting and disposing of all trees, down timber, brush, bushes and debris within designated limits.
- (b) Tree trimming shall consist of removing any designated branches and other tree portions for preservation purposes.
- (c) Selective Clearing and Thinning shall consist of cutting and disposing of designated trees, down timber, stubs, brush, bushes and debris within designated limits. This work also includes application of approved herbicides on hardwood stumps.
- (d) Removing trees shall consist of cutting and disposing of single trees, stumps and roots, located outside the limits of clearing or selective clearing and thinning limits, as indicated on the plans or as authorized.
 - 1. A single tree is defined as any tree or remains of a tree, still standing, 300 mm [12 inches] or more in its average diameter measured as specified in Subsection 201.09 and taller than 1.5 m [5 feet] measured from the ground at the base of the tree.
 - 2. A stump is defined as the remains of a single tree 300 mm [12 inches] or more at its average diameter from which the toppings have been removed and which is less than 1.5 m [5 feet] in height measured from the ground at the base of the stump.

MATERIALS

201.02 Materials. Materials shall conform to the requirements specified in the following Subsections of Division 700 -- Materials Details:

Herbicide

717.07

CONSTRUCTION REQUIREMENTS

201.03 General. The Engineer will establish clearing and selective clearing limit lines and will designate all things that are to be preserved and to remain.

Unsound or unsightly branches of trees and shrubs, designated to remain and not specified to be removed under another item, shall be removed as directed. Branches of trees extending over the roadbed shall be trimmed to provide a clear height of 6 m [20 feet] above the road and shoulder surface. Trimming shall be done by skilled workmen and in accordance with good tree surgery practices.

Alignment stakes, grade stakes, witness stakes, boundary markers, bench marks and tie points shall be preserved until permission is given for their destruction.

201.04 Clearing. In areas indicated on the plans, all trees, down timber, brush, bushes, shrubs, plants and debris not designated to remain shall be removed and disposed of.

In areas where the proposed embankment is not designated to be grubbed, as provided in Subsection 203.09, all stumps shall be cut off as close to the ground as is practicable. When stumps are to remain in the BACKSLOPE rounding of cut sections, they shall be cut flush with the final slope line.

All wood in the clearing area, except trees designated to remain, shall become the property of the Contractor, unless otherwise provided.

The Contractor shall take special care to completely dispose of all elm trees removed, by burning or by burying under soil in approved areas.

All live hardwood stumps, 25 mm [1 inch] or more in diameter located between the lines of improvement and the outermost clearing or selective clearing lines shall be treated with herbicides, unless specifically exempted.

In areas where stumps and shrubs are to remain, the surface of the ground shall not be unduly disturbed or compacted. Existing ground cover shall be preserved insofar as possible and the area shall be left neat and clean and in a condition which is reasonably consistent with the surroundings.

201.05 Selective Clearing and Thinning. In order that trees may be properly marked, the Contractor shall give the Engineer at least 2 weeks notice prior to starting work. Only those trees or bushes designated to be removed shall be cut. In no event shall selective clearing and thinning operations begin until approval is given.

All dead or diseased trees or shrubs, junk, trash, litter or foreign matter of any kind shall be removed from the areas to be enhanced. This shall include uprooted stumps and all branches, tops, trunks and dead wood, resulting from woodcutting operations or from any other causes.

Trees and shrubs to be preserved shall be carefully pruned to remove all dead, diseased and injured wood. In addition, in certain areas, the Engineer may require the branches of designated trees to be removed to a height above ground as directed. Complete clearing may be required in certain areas. Such clearing shall be included under this Subsection. Storing logs and pulpwood in thinned areas shall be avoided.

The Contractor shall avoid disturbing or compacting the existing ground surfaces as well as avoiding damage to plant growth. The use of heavy equipment, operating anywhere within the area to be selectively thinned, will not be allowed unless authorized.

Any injury to trees and shrubs which are to be preserved shall be carefully repaired. Disturbed ground surface shall be restored as nearly as possible to natural conditions.

Pruning and repairs to live trees and shrubs shall be done by skilled workmen or tree surgeons according to approved arboricultural practice. All stumps, new or old, shall be cut off as close to the ground as is practicable.

Trees falling outside the specified limits of the thinning areas shall be removed and disposed of in a satisfactory manner. Undesirable trees leaning or falling over the highway right-of-way from outside shall be cut at the property line.

201.06 Herbicides. All herbicides shall be approved by the Department of Transportation Landscape Architect. The herbicides shall be applied by Certified Pesticide Applicators in accordance with State Pesticides Control Board Regulations. With the exception of coniferous (softwood) trees, stumps over 25 mm [1 inch] in diameter resulting from cutting live hardwood trees and shrubs shall be treated with approved herbicide spray mixture. The spray mixture may be applied at any time until regrowth from the stumps has reached a height of approximately 600 mm [24 inches] except that it shall not be applied when the stumps are wet or frozen. The herbicide spray mixture shall be sprayed on all exposed surfaces of stumps and the stems of regrowth, until there is complete saturation and run-off. Particular attention to coverage shall be given to the bark and all exposed roots.

All stumps shall receive at least one treatment with the herbicide spray mixture. At the time of final acceptance, live regrowth of hardwood tree seedlings shall have been substantially eliminated. Any remaining regrowth will require another treatment prior to final acceptance.

Particular care must be taken that the herbicide mix does not come in contact with or too near live trees and shrubs that are to be preserved. Unless otherwise directed the spray mixture shall not be applied closer than 600 mm [2 feet] from the trunk of a tree that is to remain.

When directed, live stumps in specified areas shall be exempted from spraying with herbicides.

The Contractor shall be responsible for maintaining the treated area until final acceptance of the work. All damage or die-back shall be repaired at the Contractor's expense as directed. At the time of final acceptance the area shall be free of all dead, dying or damaged trees and shrubs and litter of any kind as well as free from regrowth.

201.07 Disposal. All brush, timber, logs and other woody debris shall be disposed of by approved methods. The Contractor shall make every effort to provide useful disposition of woody material which may be marketable. If the Contractor can demonstrate that a reasonably suitable market for the material is not available, other disposal methods may be approved.

Acceptable methods of disposal may include chipping and burying. Burning may be allowed when so provided by Special Provision.

- (a) Chipping. Wood chippers shall reduce woody material to chips, not over 6 mm [$\frac{1}{4}$ inch] thick by not over 200 mm [8 inches] long, and the chips shall be spread uniformly over the ground or as directed.
- (b) Burying. Brush and logs may be disposed of by burying in approved waste dumps or by placing in the portion of the embankments outside a slope 1 horizontal to 1 vertical extending from the edge of the shoulder to the existing ground and covering with a minimum of 600 mm [2 feet] of earth. Excavation or borrow used to cover the brush and logs in the slopes may be placed in layers at least 600 mm [2 feet] thick and compacted only to the extent that the stability of the slope is assured.
- (c) Burning. A Special Provision will state when burning is allowed. Logs, brush and other refuse produced as a result of clearing, may be disposed of by burning, provided pollutant type material is not used to start or maintain the fire. All fires shall be started with natural material and the fire maintained in such a manner that minimum of visible smoke is produced.

Special attention shall be given to wind direction to assure no nuisance results from smoke.

Burning shall be done in accordance with applicable laws and ordinances and under the direction of competent watchmen. Extreme care shall be taken to control the fires. Fires will not be allowed where there is any possibility of burning, scorching, overheating or otherwise jeopardizing trees, shrubs, surrounding forest cover, adjacent property or buildings nor where there is a possibility of damaging overhead wires and cables. Fires will not be allowed where undisturbed ground is to remain exposed nor on areas which have been seeded to grass or other plants.

The Contractor will be held responsible for any damage caused by fires built in the construction of the project. Such responsibilities shall include removing and disposing of burned material, replacing trees, shrubs, fences or any other material or object which has been designated to remain and seeding, fertilizing and mulching the burned areas. At the option of the Engineer, a cash settlement or a combination of replacement and cash settlement may be assessed in lieu of replacing all damaged trees and plants. When directed, the Contractor may be required to perform such work beyond the right-of-way lines.

201.08 Removing Single Trees and Stumps. When called for on the plans or otherwise designated, complete removal and disposal of single trees and stumps shall be required and shall include the backfilling of stump holes.

Trees which have been uprooted shall be removed by cutting the tree and removing the stump from the ground or, where approved, the stumps may be placed back in the hole to present a natural appearance. The area shall be graded to conform to the surrounding terrain.

201.09 Method of Measurement. Clearing, and selective clearing and thinning will be measured by the hectare [acre], determined from horizontal dimensions, acceptably and actually cleared or thinned within the limits shown on the plans or additional areas flagged by the Engineer. Areas not shown on the plans or not flagged for clearing or thinning will not be measured for payment.

As an alternative to field measurements, the Contractor and the Engineer may agree in writing that the acreage acceptably cleared for payment will be that shown in the Schedule of Items. If such an agreement is reached, no further measuring and computing of quantities will be required and the quantity referred to herein will be final.

Single trees and stumps will be measured by each unit. The size of the tree shall be the average diameter determined by circumferential measurement at a height of 1.4 m [4½ feet] above the ground. When trees are removed under this contract and the removal of the stump is also required, the stump size shall be the same size as that determined for the tree. The size of all other stumps shall be the greatest horizontal cross sectional dimension determined at the top of the stump. Trees or stumps which have multiple trunks protruding from a single base trunk shall be measured for payment as a single tree or stump.

Individual trunks of multiple trunk trees or stumps having a diameter of less than 300 mm [12 inches] will not be included to determine the size of a tree or stump.

201.10 Basis of Payment. The accepted quantities of clearing, selective clearing and thinning will be paid for at the contract unit price per hectare [acre].

The accepted quantity of single trees and stumps removed will be paid for at the contract unit price each. Payment for trees shall include removal and disposal of the entire tree except stumps.

All stumps, as specified in Subsection 201.01(d) and designated to be removed, will be paid for at the contract unit price each. Payment shall include removal and disposal of the stumps and roots.

When the Schedule of Items does not contain an estimated quantity for clearing, the work, when authorized, will be paid for under the provisions of Subsection 109.04.

When the use of herbicide or tree paint is required to complete the work included under this section, it will not be paid for directly, but will be considered as included in the other contract pay items.

Grubbing, when required, will be measured and paid for as provided in Section 203 -- Excavation and Embankment.

Payment for removal of trees and stumps, not classified as contract pay items under this Section, shall be considered included in the various contract items and no separate payment will be made.

Removal of unsound and unsightly branches and trimming branches of trees, as specified in Subsection 201.03, will be paid for under the provisions of Subsection 109.04.

Payment will be made under:

Pay Item	Pay Unit
201.11 Clearing	hectare [Acre]
201.12 Selective Clearing and Thinning	hectare [Acre]
201.23 Removing Single Tree Top Only	Each
201.24 Removing Stump	Each

SECTION 202 -- REMOVING STRUCTURES AND OBSTRUCTIONS

202.01 Description. This work shall consist of removing wholly or in part, and satisfactory disposing of all designated buildings, structures, bituminous pavement, portland cement concrete pavement and other obstructions which are required to be removed, except for the

obstructions to be removed and disposed of under other contract items. It shall also include salvaging designated materials.

CONSTRUCTION REQUIREMENTS

202.02 Removing Buildings. The Contractor shall remove and dispose of all buildings and foundations indicated.

Cavities remaining as a result of foundation or structure removal shall be filled to the level of the surrounding ground and, if within the limits of embankment or below the subgrade in excavation areas, shall be compacted in accordance with applicable embankment construction requirements.

Details of the ownership of the building and all the equipment, fixtures and materials therein, except equipment belonging to a public utility or equipment or fixtures specifically excepted and details relative to the date of availability of the property, will be stated in the Special Provision.

Written notice will be given the Contractor when any building becomes available prior to the date specified. On the above specified date, or upon notice of availability, ownership of the buildings shall transfer from the State to the Contractor who then shall proceed with the work required under this section. The buildings shall not be used or occupied for any purpose while in the right-of-way and the buildings shall be removed as soon as possible after the date available, unless otherwise authorized.

If, during the negotiations between the Department and the owners of the building specified under this section, agreements are made with the owners to move, remove or raze the buildings, the Department reserves the right to remove any or all items from the contract upon written notice to the Contractor and no payment will be made for the items. Removal of debris, when necessary under such conditions, will be accomplished under Section 629 -- Hand Labor and Section 631 -- Equipment Rental.

All debris and unusable materials shall be removed to an approved dump or waste area and buried. No material shall be disposed of by burning.

202.03 Removing Existing Superstructure, Structural Concrete, Railings and Bridges. Removing existing superstructures shall consist of removing and disposing of existing superstructure including fill, pavement, railing and all other material on or over the superstructure unless otherwise specified. Removing existing structural concrete shall be to the limits designated on the plans and shall be accomplished without damage to the portion of the structure to remain.

Removing existing bridge shall be to the limits shown on the plans.

When the material from an existing structure is to be retained by the Department, it shall be carefully dismantled by the Contractor and all materials, except those which may be

specified to be reused in the new structure, shall be loaded on trucks supplied by the Department or carefully stored by the Contractor within the right-of-way. The use of any portion of the salvaged material in connection with new or temporary construction shall not be anticipated by the Contractor. The dismantling of metal structures or railings shall, when especially provided, include the removal of all bolts and rivets necessary to disconnect the members and the match-marking of these members for future reassembling.

When the material from an existing structure is designated to become the property of the Contractor, it shall be entirely removed and disposed of out of sight of the highway and beyond the limits of the right-of-way. Such material shall not be deposited in rivers, streams or other bodies of water. If the material is to be wasted then it shall be disposed of at an approved dump or other approved location.

When practical, any suitable material removed shall be used in backfilling or for the formation of embankments and no additional allowances for payment will be made. Unsuitable or surplus material shall be disposed of in an approved waste area.

Blasting or other operations necessary for the removal of an existing structure or obstruction, which might damage new construction, shall be completed prior to placing the new work. If this is not feasible, the work shall be done only when approved and entirely at the Contractor's risk.

202.031 Removing Existing Bituminous Pavement and Concrete from Bridges. The full depth of existing bituminous pavement shall be removed from curb to curb for the entire length of the bridge. Membrane waterproofing, if present, shall also be removed in a manner approved by the Engineer.

Extreme care shall be taken to avoid damaging the concrete surface that is not to be rehabilitated. All existing concrete damaged by the Contractor, which is not specified to be removed, shall be repaired as directed by the Engineer. Such repair shall be at the expense of the Contractor.

When scarifying the top of the deck is called for, the specified depth of material shall be removed from curb to curb for the entire length of the bridge. Removal shall be accomplished by an approved scarifying machine. Areas which cannot be removed by a scarifying machine, such as adjacent to curbs, drains, and armored joints, shall be removed by using a maximum 16 kg [35 pound] chipping hammer or pavement breaker.

Existing concrete curbs, granite curbs, and concrete sidewalks shall be removed to the limits shown on the plans using a chipping hammer or pavement breaker of a size approved by the Engineer or any other method approved by the Engineer which will not damage the structural integrity of the concrete deck to remain.

Prior to removal of existing concrete curbs or sidewalks, the fascia removal line, as indicated on the plans, shall be saw cut to a depth of 25 mm [1 inch] minimum. Care shall be taken not to damage any reinforcing steel which is to remain in the bridge.

202.04 Removing Portland Cement Concrete Pavement. All portland cement concrete pavement and portland cement concrete base course designated for removal shall be broken into pieces suitable for use in construction of embankment or disposed of as directed. When used in the construction of embankments, the maximum size of any fragment shall not exceed the thickness of the layer being placed. The Contractor may, at his option and with approval, dispose of material in approved waste areas and replace with an equivalent volume of granular borrow at no cost to the State.

202.05 Method of Measurement. Removing buildings, removing existing superstructures, removing existing bridges and removing existing structural concrete will each be measured by the lump sum. Removing portland cement concrete pavement will be measured by the square meter [square yard] with no deductions made for areas occupied by existing catch basins and manholes. Removing existing structural concrete will be measured either by the cubic meter [cubic yards] in place before work starts on the particular portion of the structure to be removed or by the lump sum as specified. Removing existing railings will be measured by the meter [linear foot] in place along the grade and line of the railing from outside to outside of end posts or rail projections, whichever is greater.

The removing of existing bituminous pavement, removing of existing concrete curbs and sidewalks from bridges and scarifying of the concrete deck will each be measured for payment as one lump sum unit, complete and accepted.

202.06 Basis of Payment. The accepted quantity of removing building, removing existing superstructure, removing existing bridge and removing existing structural concrete will be paid for at the contract lump sum price which price shall be full compensation for removing and disposing of the obstructions and building foundations down to an elevation matching the surrounding ground as directed. Removing portland cement concrete pavement will be paid for at the contract unit price per square meter [square yard] which price will be full compensation for removing and disposing of pavement and pavement reinforcement. Material for backfilling holes resulting from removal of obstructions will be measured and paid for as provided in Section 203 -- Excavation and Embankments. The quantity of structural concrete removed will be paid for, either at the contract unit price per cubic meter [cubic yard] or at the contract lump sum price which price shall include disposal of the concrete. The quantity of railing removed will be paid for at the respective contract unit price per meter [linear foot] of railing removed and disposed of.

Removing and scarifying existing concrete and removing existing bituminous pavement from bridges will be paid for at the contract lump sum price for the respective contract item involved. Removing membrane waterproofing, if present on the existing deck, shall be incidental to the removing of bituminous pavement.

The payment for each contract item will be full compensation for furnishing all materials, labor, equipment, for all form work and for all other incidentals necessary to complete the work.

When the payment item calls for material to be retained by the Department, payment shall include the salvage of these materials, custody, preservation and storage on the right-of-way and disposal as provided herein. When the proposal does not include pay items for removal of structures and obstructions as provided in this Section, such work shall be incidental to the various contract items and no direct payment will be made except that removal of foundations and portland cement concrete pavement will be paid as provided in Section 203 -- Excavation and Embankment.

Pay Item	Pay Unit
202.08 Removing Building No. ____	Lump Sum
202.09 Removing Existing Superstructure- Retained by Department	Lump Sum
202.10 Removing Existing Superstructure-Property of Contractor	Lump Sum
202.11 Removing Portland Cement Concrete Pavement	square meter [Square Yard]
202.12 Removing Existing Structural Concrete	cubic meter [Cubic Yard]
202.121 Removing Existing Concrete	Lump Sum
202.123 Scarifying Concrete Deck-Top mm[inch]	Lump Sum
202.127 Removing of Existing Bituminous Pavement	Lump Sum
202.128 Removing of Existing Concrete-Curbs & Sidewalks	Lump Sum
202.13 Removing Existing Railings-Retained by Dept.	meter [Linear Foot]
202.14 Removing Existing Railings-Property of Contractor	meter [Linear Foot]
202.17 Removing Existing Structural Concrete	Lump Sum
202.19 Removing Existing Bridge	Lump Sum

SECTION 203 -- EXCAVATION AND EMBANKMENT

203.01 Description. This work shall consist of removing, hauling, disposing and compacting, if required, of all material not being removed under some other item, encountered for the construction of the project in accordance with the specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established. Excavation, except structural excavation, will be classified as common excavation, rock excavation, unclassified excavation, as hereafter defined. Material not classified as excavation which is required to construct embankments, backfill trenches and holes shall be classified as borrow.

- (a) Common Excavation shall consist of removing all material encountered in grading the project within the limits of construction and in driveways which is not otherwise classified and paid for. Common excavation shall include the removing and disposing of boulders, solid mortared stone masonry, and concrete masonry when each is less than 2 m³ [2 cubic yards] in volume and all soft and disintegrated rock which can be removed with ordinary excavating machinery. It shall include grubbing which consists of the removing and disposing of all stumps, roots, bushes, grass, turf or other objectionable material and it shall include berm ditches and cut slope downspouts.

Common Excavation shall include muck removal which shall consist of excavating and disposing of saturated or unsaturated mixtures of soils and organic matter not suitable for embankment foundation material regardless of moisture content.

Common Excavation shall also include removing and disposing of all earth material encountered in excavating for stream channel diversion, channel widening or straightening, when designated on the plans, outside the limits of structural excavation or other classifications.

- (b) Rock Excavation shall consist of removing hard igneous, metamorphic and sedimentary rock which cannot be excavated without drilling and blasting or drilling and splitting and all boulders, solid mortared stone masonry, concrete masonry, each having a volume of 2 m³ [2 cubic yards] or more.
- (c) Unclassified Excavation shall consist of common excavation and rock excavation as classified above and not measured separately.

When identical unit prices are bid for Common Excavation and for Rock Excavation, such bids shall be considered as a bid for Unclassified Excavation of the combined items and shall be so classified.

MATERIALS

203.02 Materials. Borrow shall consist of approved material required for the construction of embankments or for other portions of the work as designated and shall be obtained from beyond the limits of the required cut slopes. Unless otherwise designated in the contract, the Contractor shall make his own arrangements for obtaining borrow and shall pay all costs involved. No material shall be removed from an approved borrow pit except for use under this contract.

Material shall meet the requirements of the following Subsections of Division 700 --
Materials:

Common Borrow

703.18

Granular Borrow	703.19
Gravel Borrow	703.20
Rock Borrow	703.21

Slope blanket backfill material shall meet the requirements of aggregate for base or aggregate for subbase, Type D specified in Subsection 703.06 as directed.

203.03 Unauthorized Use of Materials. No common excavation, rock excavation, unclassified excavation or borrow which is designated for use in embankments or backfill may be diverted for the Contractor's own use. Any unauthorized use of such material will be adjusted by deducting quantities, measured by the most appropriate method, as determined, and 115 percent of the quantity deducted from the total amount.

CONSTRUCTION REQUIREMENTS

203.04 General. Prior to beginning excavating, grading, and embankment operations in any area, all necessary clearing in that area shall have been performed in accordance with Section 201 -- Clearing Right-of-Way.

Unsuitable material shall be disposed of as directed and no material shall be wasted without permission. Excavating operations shall be conducted so that material outside of the limits of slopes will not be disturbed.

The Engineer may designate as unsuitable those soils which cannot be properly compacted in embankments and all such unsuitable material shall be disposed of in approved waste storage areas or waste areas as directed.

Suitable material taken from excavation shall be used in the construction of embankment, subgrade, and for backfilling as indicated on the plans, or as directed, except that if the volume of suitable excavated material exceeds that required to construct the embankments to the grades indicated, the excess shall be used to grade the areas of ultimate development or wasted as directed.

The Contractor shall give the Engineer sufficient time before beginning excavation to take necessary cross section elevations and measurements. The Contractor shall not excavate beyond the dimensions, slopes and elevations established, and no material shall be removed prior to the staking out and cross sectioning the site. Unless otherwise authorized, borrow material shall not be placed until after all suitable excavation has been placed in the embankment unless the use of granular borrow is called for on the plans or required for use under embankments or in conjunction with the use of excavated material or for the maintenance of traffic. If the Contractor places more borrow than is required and thereby causes a waste of suitable excavation material, the amount of such waste will be measured by the method deemed most appropriate and 115 per cent of the amount deducted from the borrow volume.

When different unit prices are bid for Common Excavation and Rock Excavation, the Contractor will be required to strip earth from the ledge to provide an opportunity for the Engineer to take the necessary measurements. When identical prices are bid for Common Excavation and Rock Excavation, the Contractor will not be required to strip the earth from the ledge.

When it is necessary to temporarily remove fencing designated to remain, the fencing shall be replaced by the Contractor at his expense in as good a condition as it was originally. The Contractor shall be responsible for the confinement of livestock when a portion of the fence is removed. When new fencing for confinement of livestock is required, it shall be erected before existing fencing is disturbed. Where new fencing cannot be erected in its final location, temporary fencing shall be at the Contractor's expense.

Excavating for obliterating old roadways or salvaging material from old roadways shall include all grading operations necessary to incorporate the old roadway into the new roadway and surroundings or placing salvaged material in a stockpile as directed.

The degree of finish for grading ditches and slopes, both fill slopes and cut slopes, shall be that obtainable from machine operations. Ditches shall be constructed to within 150 mm [6 inches] above or below the grade called for on the cross sections or as otherwise modified but in no case shall the ditch be finished in a condition that will not allow the flow of water. Ditches shall be graded to the extent that puddles will not form. All provisions for measurement and payment limits shall remain in force and no payment will be made for unauthorized work done beyond authorized pay limits.

Unstable slopes subject to sliding and slumping shall be excavated to the lines and grades shown or as directed. Immediately after each location is excavated approved stone or granular slope blanket backfill material shall be placed and shaped to match the adjacent slopes.

Ledge slopes shall be scaled (cleaned of all loose material) immediately as the excavation proceeds. The ledge slope shall then be examined by the Contractor to determine if the slope is stable. If the slope is not deemed stable upon this examination, then immediate steps shall be taken by the Contractor to insure the stability of the slope during construction. There will be no additional pay for any temporary protection required for the construction of the project.

203.05 Roadway Excavation. Roadway excavation shall be maintained in such condition that the excavation surface will be well drained. Temporary drains, drainage ditches and culverts shall be constructed to intercept and divert water which may adversely affect the condition of the excavation and the prosecution of the work.

Excavation shall, in general, proceed in a direction upgrade. Subgrades shall be promptly graded and rolled to minimize absorption of water. Adjacent ditches shall be graded to the extent that puddles will not form. Grubbing areas which cannot be drained shall be promptly filled with approved excavation or borrow to such an elevation that surface drainage will be effective. If, due to unusual circumstances, drainage by gravity cannot be accomplished, the Engineer may require the Contractor to provide adequate means of pumping the area. Pumping

may be required on a 24 hour a day continuous basis and no direct compensation for cost of pumping will be made.

Muck shall be removed in such a manner to insure its complete removal with no areas remaining or trapped below the embankment. Excavated muck shall be deposited in designated waste storage areas as shown on the plans or as otherwise directed. When muck is encountered that was not contemplated on the plans, it shall be disposed of as indicated above.

Excavation adjacent to roots of trees or shrubs which are to remain shall be removed by hand.

When excavating results in a subgrade of unsuitable soil, the Engineer may require the Contractor to remove the unsuitable material and backfill the area with approved material. The Contractor shall conduct his operations in such a way that the Engineer can take the necessary measurements before the backfill is placed.

Material classified as rock, whether paid for as rock excavation or unclassified excavation, shall be excavated to the required depth. Care shall be taken that undrained pockets will not be left in the surface of the rock remaining.

The space between the rock remaining and the normal subgrade shown on the plans shall be backfilled with the designated aggregate subbase or aggregate base, pulverized rock or other approved material. The Contractor shall conduct his excavating and hauling work in a manner that will cause as little contamination as possible. Fine grading at the normal subgrade line will be required unless aggregate subbase or aggregate base material is used.

Ditches in rock cuts shall be constructed with no protrusions of rock above the designated rock cut pay lines. The space between the rock remaining and the finished surface of the ditch shall be backfilled with broken rock.

For earth and rock backslopes designated to be constructed on a 1 vertical to 2 horizontal slope or flatter, the slope shall be uniformly finished to within 150 mm [6 inches] above or 150 mm [6 inches] below the lines designated, but in no case shall projections of rock extend over 150 mm [6 inches] above the actual finished surface of the slope as constructed. Rock backslopes designated to be constructed on a 1 vertical to ¼ horizontal slope shall be excavated at least to a vertical plane.

Buried structures and obstructions, as specified in Subsection 104.07, located within the designated limits of the work, shall be removed as part of the applicable excavation item for type of work being performed. Buried structures and obstructions located below or outside the required excavation, whose removal is ordered, shall be removed and such removal paid for as Common Excavation, Rock Excavation or Unclassified Excavation, whichever is applicable.

203.06 Waste Areas. It shall be the responsibility of the Contractor to obtain necessary permits and approvals from all pertinent State and Federal agencies and from the local municipality prior to the establishment of waste areas off the project. In addition, written

permission of the property owners shall be obtained by the Contractor, including permission to dispose of waste in the area. Copies of all required permits shall be given to the Engineer.

Provisions shall be made for temporary and permanent erosion controls at waste areas which shall include, but not necessarily be limited to, grading the surface to drain, covering the surface with loam or other earthy material that will support growth and seeding and mulching. Seed and mulch shall be applied in accordance with Section 618, Seeding Method Number 2.

Entrances to waste areas located within wooded areas shall be in accordance with Subsection 203.07.

When waste areas are located within wooded areas, a screen of trees at least 30 m [100 feet] wide shall be maintained between the nearest edge of the waste area and the right-of-way line or the construction limit line.

The entrances to waste areas shall be treated in the same manner as the waste area except that if entrances in wooded areas exceed 5 m [16 feet] in width the ground shall also be replanted with trees compatible with the type growth in adjacent area. These plantings shall extend for a length of 30 m [100 feet] along the entrance road or as otherwise directed.

All trees which are damaged, uprooted or otherwise moved as a result of the waste material and trees which have had waste material placed around them to the extent that they may die, shall be cut and removed at the expense of the Contractor.

Designated waste areas may be established by the Department. When such waste areas are established, the location and other conditions relating to them will be described in the Special Provisions or on the plans.

Waste material shall not be disposed of in wetlands without prior approval and the acquisition by the Contractor of all necessary Federal, State and local permits.

"Wetlands" are those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.

In order to receive approval to dispose of waste material in wetlands the Contractor shall provide written documentation to the Engineer that no practicable non-wetland locations are available for such disposal and therefore that the wetland impacts are unavoidable. Measures to minimize harm to the wetlands shall be implemented as well as whatever mitigation measures have been considered. The Engineer will forward this documentation to the Department's Director of Environmental Services who will revise the project environmental documentation.

The Contractor shall be solely responsible for delays and costs resulting from or associated with the proposed disposal of waste material in wetlands.

203.07 Haul Roads. In wooded areas, haul roads shall be kept to a minimum width and placed at approximately right angles to the road or angled away from view of oncoming traffic.

203.08 Borrow. The location of all borrow pits and rock borrow quarries shall be approved in accordance with Subsection 106.02 and Section 657 -- Rehabilitation of Pits.

The Contractor shall notify the Engineer sufficiently in advance of opening any borrow areas so that cross section elevations and measurements of the ground surface after stripping may be taken and the borrow material can be tested before being used. Existing pits shall, when directed, be graded and shaped by the Contractor prior to being cross sectioned for original measurements.

Borrow pits shall be excavated to neat lines and all slopes shall be dressed uniformly and left in a neat condition. Prior to the completion of the project, all borrow pits and haul roads shall be graded to blend with adjacent ground, loamed if necessary, seeded and mulched. When practicable, the bottom of all pits shall be graded to drain the pit.

203.09 Preparation of the Embankment Area. When the depth of the embankment, measured vertically below subgrade, does not exceed 1.5 m [5 feet] the area on which the embankment is to be placed shall be grubbed as defined in Subsection 203.01(a). When the embankment is more than 1.5 m [5 feet], as measured above, all vegetation in the embankment area shall be cut as specified in Section 201 -- Clearing Right-of-Way.

When embankment is to be placed and compacted on hillsides or where new embankment is to be compacted against existing embankment, slopes steeper than 1 vertical to 2 horizontal shall be continuously benched by excavating steps into the existing material of sufficient width to permit operations of placing and compacting the additional material. Material removed shall be placed and compacted along with the new embankment material. When such benching is required, it will be as indicated on the plans, called for in the special provisions or as directed.

203.10 Embankment Construction-General. Layers of material for embankments shall start at the deepest portion of the fill and as placement progresses, layers shall be constructed approximately horizontal. Except for the first layer over swampy ground and cleared areas, roadway embankment of earth material shall be placed in layers not exceeding 200 mm [8 inches], loose measure, unless otherwise approved and the material compacted as specified before the next layer is placed.

When it is impractical to construct layers over the full width of the cross section, partial width layers may be authorized.

Effective spreading equipment shall be used on each layer to obtain uniform thickness. Each layer shall be crowned and maintained free of ruts and ridges to provide direct drainage of water from the embankment. As the compaction of each layer progresses, grading and manipulating will be required to assure uniform density. Construction equipment shall be routed uniformly over the entire surface of each layer.

Embankments within 15 m [50 feet] of a bridge abutment, structural plate or box culvert type structure shall be compacted by the moisture and density control method as specified in Subsection 203.12, except that rock embankments may be constructed over culverts as specified in Subsection 203.15.

Water shall be added or removed, if necessary, in order to obtain required compaction. Aeration of excavated roadway materials to reduce the moisture content to within specified limits shall be as specified under Subsection 631.04.

When placing layers of specified thickness is not feasible, such as filling in water or over swampy ground, the initial layer of embankment may be constructed in one layer to an elevation where bridging will be accomplished. In embankment areas where no grubbing is required, the material placed in the first layer shall be of sufficient depth to cover all stumps.

When the excavation or borrow consists predominantly of fragments of such size that the material cannot be placed in embankments in layers of specified thickness without breaking down the pieces, such material may be placed in layers in thicknesses not exceeding the approximate average size of the larger rocks but in no case shall layers exceed 600 mm [2 feet]. Rocks exceeding this thickness shall be separated and collectively placed in accordance with the requirements for rock embankments. Each layer shall be leveled and smoothed with suitable leveling equipment and by even distribution of rock spalls and finer rock fragments or earth. The Engineer may test any or all layers by moisture and density control as specified in Subsection 203.12 which are constructed in depths exceeding 200 mm [8 inches]. The layers so constructed shall not be placed above an elevation 600 mm [2 feet] below the finish subgrade. The remainder of the embankment shall be composed of suitable material smoothed and placed in layers not exceeding 200 mm [8 inches], loose thickness, and compacted as specified for earth embankments.

Where guardrail is to be installed, rock shall not be placed in the embankment under the location of the guardrail to an elevation 1.2 m [4 feet] below the finished grade of the shoulder. Rocks, broken concrete and other solid materials shall not be placed in any portions of embankments where piling is to be placed or driven or where utility conduits are to be placed.

Excess or unsuitable excavated material, including rock and boulders, which cannot be used in embankments shall be placed in the nearest available waste areas. When it is impossible to dispose of all material in the manner described, the remainder shall be disposed of in approved waste areas.

When material obtained from roadway excavation is unsatisfactory for use in the formation of embankments due to excessive moisture content, can be rendered satisfactory for such use by combining it with granular material, the unsatisfactory material shall be combined with granular borrow or granular excavation when and as directed by the Engineer.

If the embankment is required to be deposited on only one side of abutments, wing walls, piers or culvert headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted excessively to the extent that it will cause overturning or excessive pressure against the structure. When embankment is to be placed on both sides of a

concrete wall, structural plate or box type structure, operations shall be so conducted that the embankment is always at approximately the same elevation on both sides of the structure.

At the close of each day's work, the embankment surface shall be graded, crowned, smoothed, rolled and sealed against infiltration of water.

The portion of the embankment and subbase outside a 1 vertical to 1½ horizontal slope extending from the edge of the finished shoulder to the existing ground, as shown on the Standard Detail entitled "Disposal of Waste Materials", will be required to be compacted only to the extent that stability of the slope is assured. As construction of the embankment progresses, material placed in the portion of the embankment outside the 1 vertical to 1½ horizontal slope shall not be placed above the elevation of the surface of the main embankment unless provisions are made to allow drainage of surface water from the embankment. The surface of the slopes shall be finished to present a uniform neat appearance.

The portion of the embankment inside the aforementioned 1 vertical to 1½ horizontal slope lines shall be compacted in accordance with the designated embankment compaction requirements specified for the project.

203.11 Construction of Earth Embankment-Layer Method. The layer method will be required unless otherwise specified. Unless otherwise approved the material shall be deposited and spread upon compacted material in full width layers not more than 200 mm [8 inches] in depth, loose measure. Clay or loam soils shall be compacted by use of sheepsfoot or tamping type roller having a minimum weight on each tamper, under working conditions, of 1725 kPa [250 pounds per square inch] of cross sectional bearing area. Sand or gravel soils shall be compacted by vibratory type compaction equipment or by pneumatic tired equipment and, if necessary, by the addition of water. A combination of the above or other methods capable of producing equivalent results may be used. The compacting operations shall be continued until each layer is compacted to its full depth and width.

With approval, the Contractor may place layers in excess of 200 mm [8 inches] and less than 600 mm [24 inches], loose measure, providing the specified compaction requirements are obtained and the Contractor agrees to make necessary test excavation for the Engineer to determine density.

The Contractor will be required to demonstrate that the compaction equipment and methods are obtaining satisfactory compaction.

Satisfactory compaction for the purpose of the demonstration is defined as not less than 90 percent of the maximum density. The maximum density shall be determined in accordance with AASHTO T180, Method C or D, corrected by the Soils Laboratory Adjustment Chart, available at the MDOT Central Laboratory, Bangor, Maine. Field density tests will be made in accordance with AASHTO T191, adjusted to include only the material passing a 19 mm [$\frac{3}{4}$ inch] sieve or by an approved method using a calibrated nuclear device.

203.12 Construction of Earth Embankment with Moisture and Density Control. The contract will designate the areas to be constructed with moisture and density control and the

distance below subgrade to which such methods shall be applied. The moisture content at the time of compaction shall be suitable to obtain the required density. The maximum density shall be determined in accordance with AASHTO T180, Method C or D, corrected by the Soils Laboratory Adjustment Chart available at the MDOT Central Laboratory, Bangor, Maine. Field density tests will be made in accordance with AASHTO T191, adjusted to include only the material passing a 19 mm [$\frac{3}{4}$ inch] sieve or by an approved method using a calibrated nuclear device.

All material in embankments above the elevation designated on the plans for moisture density control shall be placed at a moisture content suitable to obtain the required density. Each layer placed with controlled moisture shall be compacted to not less than 90 percent of the maximum density.

Density requirements will not apply to the portions of embankments constructed of material which cannot be tested in accordance with AASHTO T191 or when the material contains more than 30 percent material retained on a 50 mm [2 inch] square mesh sieve.

203.13 Vacant and 203.14 Vacant

203.15 Construction of Rock Embankments. The material for rock embankment shall be placed in compacted layers not exceeding 1 m [3 feet] in depth. Depositing the rock directly over the end of the fill from the hauling equipment will not be permitted; it shall be deposited on the fill and pushed into place. The top of the rock embankment shall be so choked that there will be no infiltration of the earth embankment placed on the top of the rock embankment.

This method shall be used only in fills in excess of 1.2 m [4 feet] in depth. In no case shall the rock embankment be placed within 300 mm [1 foot] of subgrade unless authorized.

When structures are located under rock embankment, they shall be covered with not less than 600 mm [2 feet] of earth excavation or borrow before the rock embankment is placed over the structures.

203.16 Winter Construction of Embankments. Frozen material shall not be placed in the core embankment. The construction of embankments may continue during cold weather only when all frozen material in the top of the core embankment or the existing ground is moved to the waste area before placing additional material. When this procedure results in additional borrow quantity the additional borrow will not be paid for directly.

Compaction shall be in accordance with the specified method of embankment construction. When the prevailing temperatures are below -1 °C [30 °F] all material used in embankment construction shall have a moisture content, at the time of compaction, equal to or less than the optimum moisture content.

The embankment shall not be constructed upon frozen material except that such construction of embankments may be allowed providing the total depth of the added fill, including bases, plus the depth of the frozen material beneath does not exceed 1.5 m [5 feet]. Frozen material may be left in the embankment only if it has been compacted as specified prior to freezing. The Contractor shall not resume construction of any embankments built in this

manner until all frozen material has thawed. If test holes are required to make this determination they shall be dug and backfilled with satisfactory compaction at the Contractor's expense. Before additional material is added, uncompacted material on the surface of such embankments shall be either recompactd in accordance with the specified method of embankment construction or removed.

203.17 Preparation and Protection of the Subgrade. Unless otherwise provided, the subgrade shall be brought to a condition of uniform stability and compacted for the full width of the roadway by grading and rolling operation and shall be maintained to no tolerance above or 75 mm [3 inches] below the required grade and cross section. The surface shall be compacted to uniform density and stability and graded to the extent that puddles of water will not form. Additional material required as a result of low subgrade shall be furnished and placed at the expense of the Contractor.

The required compaction shall be the same as specified for embankments. When the subgrade occurs in cuts, the required compaction shall apply to a depth of 150 mm [6 inches] below subgrade unless otherwise specified.

The Contractor shall protect the subgrade from damage. Ditches and drains along the roadway shall be maintained to effectively drain the subgrade. In no case shall vehicles be allowed to travel in a single track and form ruts. No material shall be deposited on a subgrade until the subgrade has been approved.

203.18 Method of Measurement. Except as otherwise provided, excavation and borrow will be measured by the number of cubic meters [cubic yards] measured in its original position by cross sectional elevations of the area excavated. Measurements will include slides in common excavation and unclassified excavation, not attributable to carelessness of the Contractor, and authorized excavation of earth, rock, shale, muck or other unsuitable material. Volumes will be computed by the average end area method or by other methods generally recognized as conforming to good engineering practice.

When granular borrow or gravel borrow is placed for backfill behind bridge abutments and around structural plate pipes, pipe arches, and plate arches to the lines, grades and dimensions shown on the plans, the quantity measured for payment will be that shown on the plans. No further measuring or computing will be necessary except under the following conditions: when the structure is founded on ledge, the quantity measured for payment will be the quantity of borrow actually placed to maximum allowable horizontal dimensions shown on the plans.

Muck excavation, to be measured for payment as common excavation, will be the number of cubic meters [cubic yards] of material acceptably excavated from areas shown on the plans or other authorized areas not shown on the plans or placed in waste storage areas or hauled to an approved waste area. Muck excavation shall be measured in its original position by cross sectional elevations and the volume computed by the average end area method. If muck is stored in excess of the maximum slope requirements of any waste storage area, the amount requiring reloading, hauling and disposing of in other waste storage areas or approved waste areas will not again be measured for payment.

When it is impractical to measure excavation by the cross sectional method due to the erratic location of isolated deposits, acceptable methods involving three-dimensional measurements may be used. When small quantities of borrow are involved and it is impractical to measure in its original position a quantity not exceeding 2 000 m³ [2,000 cubic yards] per item for a single project may be measured in vehicles at the point of delivery and a quantity not exceeding 5,000 m³ [5000 cubic yards] per item for a single project may be measured in place. When measured in vehicles the quantity for payment shall be 90 percent of the quantity determined for earth and 75 percent of the quantity determined for rock as shown on delivery slips. When measured in place the amount for payment shall be 115 percent of the quantity so measured for earth material and 75 percent of the quantity so measured for rock.

Unless otherwise authorized, measurement for excavation in earth cuts will be made to the designated slopes. Field changes made by the Engineer will be measured by cross sections or by other acceptable methods. Elevations for final cross sections shall be determined at the surface of the finished ground with no additional allowance for thickness of loam, sod, riprap, hay mulch, or other type of ground cover except that excavation for slope gravel blanket will be measured by the cubic meter [cubic yard].

Unless otherwise authorized, measurement for excavation in rock slopes designated to be constructed on a 1 vertical to 2 horizontal slope or flatter will be made to the designated slope line providing the finished slope is within tolerances described in Subsection 203.05. If the finished slope line is not within the tolerances described, payment will be made to the designated cut slope line or to the finished slope line, whichever yields the lesser quantity.

Unless otherwise authorized, measurement for excavation in rock slopes designated to be constructed on a 1 vertical to ¼ horizontal slope will be made to the designated slope providing the rock is excavated beyond a vertical plane. There will be no payment for material removed beyond the designated slope line.

Unless authorized, material placed in embankments outside a surface parallel to and 150 mm [6 inches] beyond the neat line of embankment slope or 300 mm [12 inches] beyond the neat line of the waste storage area in which waste has been placed will not be included in the quantity for payment and will be deducted from the borrow at 100 percent of the material so measured in place.

The elevations for final cross sections for excavation shall be determined at the surface of the finished ground with no additional allowance for thickness of loam, sod, riprap, temporary erosion control blanket, hay mulch or other type ground surface except that excavation for slope gravel blanket will be measured by the cubic meter [cubic yard].

Measurements will be made for unsuitable materials actually excavated and removed to obtain proper compaction in cut sections and in foundations for fill sections.

Aeration of excavated materials to reduce moisture content to specified limits will be measured as specified under Section 631 -- Equipment Rental.

203.19 Basis of Payment. The accepted quantity of excavation and borrow will be paid for at the contract unit price per cubic meter [cubic yard] for each of the pay items included in the Schedule of Items. Payment shall be full compensation for obtaining borrow when required and for excavating, loading, hauling, placing, grading and compacting all material necessary for the formation of embankments. It shall also include full compensation for disposing of unsuitable and surplus material when necessary. It shall also include excavation in embankments for determining compaction density.

Haul, connected with the disposal of waste or surplus material or both, shall be limited to a maximum distance of 600 m [2,000 feet] beyond the limits of the project for disposal in flattening slopes or other roadway work. If no disposal areas are designated the haul shall be made to an approved waste area supplied by the Contractor.

Payment for removal of unstable material below subgrade in cuts will be paid at the contract unit price per cubic meter [cubic yard] for Common Excavation or Unclassified Excavation whichever is appropriate.

Payment for placing and compacting any backfill, except Special Backfill, placed in accordance with Section 206 -- Structural Excavation, will not be paid for separately but will be included in the payment for any one of the related excavation items, provided however, there is suitable excavation material available in its original position at the time of backfilling. When there is no suitable material available for backfilling, the material authorized will be paid for under the contract item for the class of material used.

When rock is encountered and no item is included in the contract for its removal, the excavation of the rock will be paid for at 6 times the contract unit price for common excavation.

The furnishing and placing of backfill material between the rock remaining and the normal subgrade line of rock cuts will not be paid for directly, but shall be considered incidental to the work. The quantity of Aggregate Subbase or Aggregate Base for payment in rock cuts shall include only the material placed above the normal subgrade lines.

Earth material from beyond the designated slope lines on earth cut slopes as specified in Subsection 203.18 and when authorized, may be paid for, when used to construct embankments, at the contract unit bid price for excavation or borrow, whichever is less. Costs for furnishing and placing material necessary to backfill and to grade rock cut slopes designated to be constructed on a slope of 1 vertical to 2 horizontal or flatter, will be considered to be included under the payment for the material used, either excavation or borrow.

When muck is encountered the excavation of the muck will be paid for at the contract unit price bid for Common Excavation or Unclassified Excavation.

Excavation which requires more than one handling prior to final placement in the embankments including material placed as backfill and loamy top soil to be stockpiled and reserved for later use on the slopes, will be paid for at the contract unit price for Common Excavation, Unclassified Excavation or Rock Excavation, as the case may be, for each handling approved. It may be paid for under another contract item for the second handling when so authorized. Each handling shall be considered to include the operations of excavating, loading, transporting, unloading and disposing of earth or rock material.

Excavation for unstable slopes for slope blanket backfill, as specified in Subsection 203.04, will be paid for at twice the contract unit price bid for common excavation. Backfill material will be paid for as specified in Subsection 304.07.

Excavation for benching to receive embankments will not be paid for directly but shall be incidental to the other contract items.

Water added to embankment material to aid in compaction will not be paid for directly but shall be considered included in the contract items.

Payment for compacting the soils in the abutment and pier areas, after the top soil has been removed will not be made directly but shall be considered included in the other contract items.

Machine aerating, for aerating excavated material only, will be paid for as specified under Section 631 -- Equipment Rental.

Removing portland cement concrete pavement and portland cement concrete base course, when not included in the contract as a separate pay item, will be paid for under Pay Item 203.21.

Payment for excavating or filling and compacting material in building or other foundation holes, whether existing or created by the removal of structures and obstructions, will be made under the appropriate pay item for excavation or borrow and no additional allowances will be made.

All work and materials required to grade, loam, seed and hay mulch waste areas and haul roads to and from waste areas to eliminate unsightly conditions and to control erosion will not be paid for directly but will be considered included in the work of the various classifications of excavation all as specified in Subsection 203.06.

Stripping pits to obtain necessary borrow will not be paid for separately but will be considered included in the other contract items.

When common excavation and rock excavation are reclassified as unclassified excavation, payment will be made for the reclassified items under Pay Item 203.22, Unclassified Excavation at the identical unit bid price.

Unless otherwise provided in contracts with common excavation, rock excavation or unclassified excavation items, grading, furnishing and placing loam, seed and mulch in waste areas shall be considered incidental to the contract and no separate payment will be made.

In Contracts that do not contain Common Excavation or Unclassified Excavation items, grading, furnishing and placing loam, seed and mulch in waste areas will be paid for under applicable pay items of the contract.

Payment will be made under:

Pay Item	Pay Unit
203.20 Common Excavation	cubic meter [Cubic Yard]
203.21 Rock Excavation	cubic meter [Cubic Yard]
203.22 Unclassified Excavation	cubic meter [Cubic Yard]
203.24 Common Borrow	cubic meter [Cubic Yard]
203.25 Granular Borrow	cubic meter [Cubic Yard]
203.26 Gravel Borrow	cubic meter [Cubic Yard]
203.27 Rock Borrow	cubic meter [Cubic Yard]

SECTION 204 -- SHOULDER REHABILITATION

204.01 Description. This work shall consist of rehabilitating existing shoulders by grading and compacting shoulders, and furnishing, placing, grading and compacting new shoulder aggregate to required grade.

MATERIALS

204.02 Aggregates. New shoulder aggregate shall be material meeting the requirements of Subsection 703.10, Aggregate for Untreated Surface Course and Levelling Course or Subsection 703.06(b) Aggregate for Subbase, Type D.

CONSTRUCTION REQUIREMENTS

204.03 Existing Shoulder. The existing shoulder shall be prepared by grading with power equipment to provide a surface on which to place an aggregate course. All sod, tar-penetrated strips and other unsuitable material shall be removed to the extent required by the Engineer. Suitable excavated granular material may be used to fill low areas and to widen out to provide a uniform shoulder width as required. Where required by the Engineer the edge of the existing traveled lane shall be cut to provide a uniform edge.

For proposed paved shoulders the surface of the existing shoulder shall be graded and compacted approximately parallel to the proposed finished paved shoulder surface.

Surplus material shall be incorporated into embankments or disposed of in an approved waste area.

204.04 New Aggregate. After preparation of the existing shoulder and where the thickness of new shoulder aggregate to be placed exceeds 100 mm [4 inches], material meeting the requirements of Aggregate for Subbase, Type D or Aggregate for Untreated Surface Course shall be placed to the required grade. Where the thickness of new shoulder aggregate to be placed is 100 mm [4 inches] or less, material meeting the requirements of Aggregate for Untreated Surface Course shall be used. The Contractor may, at his option, grade the existing shoulders to an elevation of 100 mm [4 inches] or more below the proposed finished gravel surface and place material meeting the requirements of Aggregate for Subbase, Type D, full depth.

204.05 Surface Tolerance. The completed surface of the shoulder shall be shaped and maintained to a tolerance, above or below the required cross sectional shape of 10 mm [3/8 inch].

204.06 - 204.09 Vacant

204.10 Method of Measurement. The quantity of rehabilitation of existing shoulders measured for payment will be the number of square meters [square yards] shown in the Schedule of Items in the contract.

This quantity will be considered final, and no adjustments will be made, except when the quantity shown in the Schedule of Items is added to or deducted from, when changes to the plans are made by the Engineer.

204.11 Basis of Payment. The accepted quantity of rehabilitation of existing shoulder will be paid for at the contract unit price per square meter [square yard]. No adjustment will be made to the quantity for payment, except as described under Method of Measurement above. Payment will be full compensation for cutting the edge joint, removing pavement, curb and other unsuitable material, grading and compacting the existing shoulder, disposing of surplus and unsuitable material, and for furnishing, placing, grading, and compacting new aggregate to the required depth.

Additional material required as a result of cross-slope variance of the pavement surface will not be paid for directly, but will be considered incidental to the contract unit price per square meter [square yard] of rehabilitation of existing shoulder.

Grading, furnishing and placing loam, seed and mulch in required waste areas will be considered incidental to the contract and no separate payment will be made.

Payment will be made under:

Pay Item	Pay Unit
204.41 Rehabilitation of Existing Shoulder, Plan Quantity	square meter [Square Yard]

SECTION 205 -- SHOULDER RECONSTRUCTION

205.01 Description. This work shall consist of reconstructing existing shoulders by excavating, grading and furnishing and compacting new shoulder aggregate in accordance with the thickness and typical sections shown on the plans.

MATERIALS

205.02 Aggregates. New shoulder aggregate shall be material meeting the requirements of Subsection 703.06(a) Aggregate for Base, Type B.

CONSTRUCTION REQUIREMENTS

205.03 Existing Shoulder. The existing shoulder shall be excavated to the depth shown on the typical section and graded to a tolerance, above or below the required cross sectional shape, of 19 mm [3/4 inch]. Where required by the Engineer, the edge of the existing travel lane pavement shall be cut to provide a uniform edge.

Excavated material shall be incorporated into embankments, used to flatten existing slopes as directed or disposed of in an approved waste area.

205.04 New Aggregate. After excavation of the existing shoulder, new shoulder aggregate shall be placed and compacted to the required grade.

205.05 Surface Tolerance. The completed surface of the shoulder shall be shaped and maintained to a tolerance, above or below the required cross section shape of 10 mm [3/8 inch].

205.06 Method of Measurement. The quantity of reconstruction of existing shoulders measured for payment will be the number of square meters [square yards] shown in the Schedule of Items in the Contract.

This quantity will be considered final, and no adjustments will be made, except when the quantity shown in the Schedule of Items is added to or deducted from, when changes to the plans are made by the Engineer.

205.11 Basis of Payment. The accepted quantity of existing shoulder will be paid for at the contract unit price per square meter [square yard]. No adjustment will be made to the quantity for payment, except as described under Method of Measurement above. Payment will be full compensation for cutting the edge joint, removing pavement, curb and other unsuitable material, excavating, grading and compacting the existing shoulder, disposing of surplus and unsuitable material, and for furnishing, placing, grading, and compacting new aggregate to the required depth.

Grading, furnishing and placing loam, seed and mulch in required waste areas will be considered incidental to the contract and no separate payment will be made.

Payment will be made under:

Pay Item	Pay Unit
205.41 Reconstruction of Existing Shoulder, Plan Quantity	square meter [Square Yard]

SECTION 206 -- STRUCTURAL EXCAVATION

206.01 Description. This work shall consist of excavating, hauling and backfilling or disposing of all material encountered for the installation and construction of drainage and minor structures and for major structures in accordance with these specifications and in reasonably close conformity with the lines, grade and typical cross sections shown on the plans or established. Excavating for structures below designated excavation limits as specified or shown on the plans will be included under this Section. Material which is required to be excavated under another item shall not be included under this item.

Ditches at inlets and outlets of culverts, special ditches and outlet ditches therefrom, all as shown on the plans, shall be constructed and paid for under Section 203 -- Excavation and Embankment.

- (a) Drainage and Minor Structures shall include pipe culverts, pipe arches, underdrains, catch basins, manholes, structural plate units, box culverts, culvert end walls, concrete steps and other minor structures.
- (b) Major Structures shall include abutments and piers for bridges, rigid frame structures and masonry retaining walls.
- (c) Special backfill shall consist of obtaining, hauling and placing selected material suitable for the location where it is to be used. Structural backfill as a contract item will be called for on the plans or in the proposal.

CONSTRUCTION REQUIREMENTS

206.02 Construction Methods. The Contractor shall notify the Engineer a sufficient length of time in advance of the beginning of structural excavation so that necessary elevations and measurements may be taken of the undisturbed ground. When solid rock is encountered which is to be removed, the Contractor shall uncover the rock and provide ample opportunity for the Engineer to take the necessary measurements of the undisturbed rock. Soil erosion control devices shall be in place at this time.

When the foundation material is soft or otherwise unsatisfactory the excavation shall be carried to a depth designated and the material removed below the elevation shown on the plan and shall be replaced with approved granular material, thoroughly compacted, or a lower elevation for the bottom of the structure shall be established.

Suitable material removed from the excavation area including that material removed from beyond the specified excavation pay limits shall be used for backfilling or for the formation of embankments and no additional allowances for payment will be made. Unsuitable or surplus material shall be disposed of as directed.

When the foundation is to be placed on solid rock, the rock shall be excavated to a firm surface, either level stepped or serrated. When solid or disintegrated rock or boulders are encountered the rock shall be excavated to a designated depth below the bottom of the proposed structures. Except for installations of underdrain, the material so removed shall be replaced with selected fine compressible material such as sand and uniformly compacted and shaped in accordance with Subsection 603.04.

When the structure is to rest on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation. If the surface upon which the structure is to rest is disturbed, it shall be regraded and recompact to the extent directed by the Engineer.

After each excavation is completed, the Contractor shall notify the Engineer and no culverts or masonry shall be placed, foundation piles driven or other installations made, until the depth of the excavation and the character of the foundation material has been approved.

Before drainage or underdrain pipe is installed in cut areas where common excavation, unclassified excavation or muck excavation is removed below the subgrade elevation shown on the plans, the undercut roadbed shall be filled with approved granular material to a depth sufficient to support construction equipment. All fill material shall be compacted as required.

206.03 Backfilling. Backfilling shall consist of placing suitable material in all spaces excavated and not occupied by drainage structures, bridge structures and other permanent structures up to the elevation of the existing ground or other elevations shown on the plans or designated. Except for underdrain backfill and for structural plate pipe units, backfill material for drainage and minor structures shall be fine readily compressible soil or granular material, at or near optimum moisture content, and shall not contain stones larger than 75 mm [3 inches], frozen lumps, chunks of clay, mineral matter or any other objectionable material. Backfill material for major structures shall be granular borrow or other material designated on the plans and shall be at or near optimum moisture content and shall not contain stones larger than 75 mm [3 inches], frozen lumps, chunks of clay, mineral matter or any other objectionable matter.

Backfill shall not be placed against gravity sections of masonry abutments, wing walls, box culverts or other structures requiring forms, until the masonry has been in place at least 7 days. For reinforced sections, no backfill shall be placed until the masonry has been in place at least 14 days. Backfilling around pipes, catch basins and manholes, the joints of which are made with portland cement mortar, shall not be done until the mortar has been in place at least 12 hours unless methods approved by the Engineer are used to protect the mortar from being disturbed.

Except for structural plate units, backfill material shall be uniformly distributed in layers of not more than 200 mm [8 inches] in depth, loose measure, and each layer thoroughly compacted by use of approved compactors before successive layers are placed. When backfill is being placed around a pipe or structure, operations shall be so conducted that the fill is always at approximately the same elevation on both sides. Water shall be added when necessary to increase the moisture content of the backfill material to obtain compaction. Puddling or jetting of backfill will not be allowed unless specifically provided in the contract.

Structural plate units shall be backfilled in accordance with Section 509 -- Structural Plate Pipes, Pipe Arches and Arches.

Unless otherwise indicated on the plans or directed, all sheeting and bracing used during structural excavation shall be removed by the Contractor following the completion of the work, and all voids resulting from use of the sheeting and bracing backfilled where necessary.

206.04 Method of Measurement. Structural excavation will be measured by the number of cubic meters [cubic yards] of material removed, measured in its original position acceptably excavated in conformity with the plans or as directed.

When structures are to be installed where roadway excavation is to be removed, only the excavation beyond and below the roadway excavation limits will be classified as structural excavation.

- (a) Drainage and Minor Structures: For these structures there will be no measurement for structural earth excavation except excavation required below a plane parallel with and 300 mm [12 inches] below the bottom of the aforementioned structures, as shown on the plans, hereafter called Structural Earth Excavation, Below Grade. When measured for payment, the quantity of Structural Earth Excavation, Below Grade, will be the amount actually excavated, provided the maximum allowable horizontal dimensions do not exceed those bounded by vertical surfaces 375 mm [15 inches] from the structure, except 450 mm [18 inches] outside the lines of the base of catch basins, manholes, structural plate units, and box culverts, and to the vertical neat lines of underdrain trenches, as shown on the plans.

When rock is required to be excavated for installation of these structures, the depth for measurement will be the actual depth required in accordance with the construction specifications or as otherwise designated for a maximum vertical dimension of 300 mm [1 foot] below the bottom of the invert of the pipe for culvert pipe and for underdrain and 300 mm [1 foot] below the bottom of the base for catch basins and manholes. The quantity of rock will be the number of cubic meters [cubic yards] actually removed provided the maximum allowable horizontal dimensions do not exceed those bounded by vertical surfaces specified in the preceding paragraph. Any removal of solid rock for the purpose of leveling, stepping or serrating, as shown on the plans or determined, shall be measured within the aforementioned limits.

- (b) Major Structures: For major structures, the quantity to be measured for payment will be that shown on the plans. No further measuring or computing will be necessary except under the following conditions: when the structure is founded on ledge, the quantity to be measured for payment will be the quantity of earth actually excavated to the top of ledge and to maximum allowable horizontal dimensions bounded by vertical surfaces 450 mm [18 inches] outside the neat lines of the base as shown on the plans.

When the outermost limit of French Drains exceeds the vertical planes stated above, the limit to be measured for payment will be extended upward from the bottom of the french drain on a vertical plane bounded by the outermost limit of the French Drain.

When rock is required to be excavated for the construction of major structures to definite elevations as shown on the plans, or elevations designated by the Engineer after the rock has been exposed, the maximum depth of measurement for payment will be to a horizontal plane or planes located 300 mm [12 inches] below the elevation shown or designated.

Removal of solid rock, for the purpose of leveling, stepping or serrating, as shown on the plans or determined, shall be measured within the aforementioned limits and paid for as structural rock excavation. When earth is required to be removed to uncover existing rock, it will mean to excavate to undisturbed solid rock and will be so measured for payment.

- (c) Special Backfill. The quantity of Special Backfill to be measured for payment as a contract item will be the number of cubic meters [cubic yards] of material acceptably placed and measured in place, but will not include replacement of material excavated beyond the specified pay limits for structural excavation.

206.05 Basis of Payment. The accepted quantities of structural excavation, when specified to be paid for separately, will be paid for at the contract unit price per cubic meter [cubic yard]. The work, whether paid for separately or incidental to the structure, shall include the placing and compacting of backfill, the formation of any embankments made with material from structural excavation and the disposal of all surplus or unsuitable material, unless otherwise specified.

Earth excavation for installation of drainage and minor structures, except that which is defined as "Below Grade" will not be paid for and all costs for such excavation and disposal of materials will be considered incidental to the contract unit price per item for the structure being installed or constructed.

Rock excavation for the installation of these structures will be paid for at the contract unit price for Pay Item 206.07, Structural Rock Excavation -- Drainage and Minor Structures.

The accepted quantity of Structural Earth Excavation- Drainage and Minor Structures, Below Grade and of Structural Rock Excavation-Drainage and Minor Structures, will be paid for at the contract unit price per cubic meter [cubic yard].

When rock is encountered and no Structural Rock Excavation-Drainage and Minor Structures item is included in the contract, the excavation of the rock will be paid for at 16 times the contract unit price per cubic meter [cubic yard] for Common Excavation.

When rock is encountered and no Structural Rock Excavation-Major Structures or Structural Rock Excavation-Piers is included in the contract, the excavation of the rock will be

paid for at 6 times the contract unit price for structural earth excavation of the corresponding classification.

When it is necessary to excavate below the elevation shown on the plans for abutments, masonry retaining walls, piers or rigid frame structures, payment for such excavation will be made at 1½ times the contract unit price for the item classification applying where the extra depth is required.

Protective systems and/or additional excavation for backsloping required for structural excavation will not be measured for payment, but will be considered included in the payment for the related contract item(s).

When no bid item appears in the contract for clearing drainage ways, maintenance of traffic, special detours or cofferdams, any necessary work of this type will not be paid for directly but will be considered incidental to the work. Unless otherwise specified, payment under the pertinent contract items shall include costs of all pumping, bailing, drainage, sheeting, bracing and incidentals required for proper execution of the work.

Backfill or bedding materials, except for material used to backfill underdrain, whose source is other than structural excavation, will be paid for under the class of material used. Material used to backfill underdrain will not be paid for but shall be considered incidental to the cost of the underdrain.

Excavation for channels, berm ditches and cut slope downspouts will be paid for under Section 203 -- Excavation and Embankment.

Special backfill will be paid for at the contract unit price per cubic meter [cubic yard].

Payment will be made under:

Pay Item	Pay Unit
206.061 Structural Earth Excavation-Drainage Minor Structures Below Grade	cubic meter [Cubic Yard]
206.07 Structural Rock Excavation-Drainage & Minor Structures	cubic meter [Cubic Yard]
206.082 Structural Earth Excavation-Major Structures	cubic meter [Cubic Yard]
206.092 Structural Rock Excavation-Major Structures	cubic meter [Cubic Yard]
206.10 Structural Earth Excavation-Piers	cubic meter [Cubic Yard]
206.11 Structural Rock Excavation-Piers	cubic meter [Cubic Yard]
206.14 Special Backfill	cubic meter [Cubic Yard]

SECTION 207 -- BRUSH MATTING

Reserved

SECTION 208 -- SAND DRAINS

Reserved

SECTION 209 -- WICK DRAINS

Reserved

SECTION 210 -- CRUSHED STONE WINDROWS

Reserved

DIVISION 300 -- BASES

SECTION 301 -- VACANT

SECTION 302 -- VACANT

SECTION 303 -- VACANT

SECTION 304 -- AGGREGATE BASE AND SUBBASE COURSE

304.01 Description. This work shall consist of furnishing and placing one or more courses of aggregates on a prepared surface in accordance with the specifications in reasonably close conformity with the lines, grades, thicknesses and typical cross sections, as shown on the plans or established.

MATERIAL

304.02 Aggregate. Aggregates shall conform to the requirements specified in the following Subsections of Division 700 -- Materials:

Aggregate Base	703.06(a)
Aggregate Subbase	703.06(b)

Aggregate for subbase or base courses shall be material meeting the aggregate type requirements specified in the following table.

Material	Aggregate Type (Subsection 703.06)
Aggregate Subbase Course, Gravel, Top 225 mm [9 inches]	D
Aggregate Subbase Course, Gravel Below 225 mm [9 inches]	¹ D or E
Aggregate Subbase Course, Granular	G
Aggregate Subbase Course, Sand	F
Aggregate Base, Course, Crushed	² A or B
Aggregate Base, Course, Screened	² B or C

¹. Contractor's option

². Will be designated on the plans

The portion of material passing a 75 mm [3 inch] sieve, for the various classes of aggregate base and aggregate subbase, at the time it is deposited on the roadbed shall conform to the gradation requirements of the contract. Oversized stones shall be removed from the aggregate before depositing on the roadway. Oversized stones are stones which will not pass a 150 mm [6 inch] square mesh sieve.

CONSTRUCTION REQUIREMENTS

304.03 Placing. The maximum compacted thickness of any aggregate subbase or aggregate base course layer shall not exceed 300 mm [12 inches] unless the Contractor demonstrates by a test section that the required compaction can be obtained. If compacted layers more than 300 mm [12 inches] are allowed, the Contractor shall agree to make the necessary excavations and backfilling in the course for the Engineer to determine the density.

When layers are constructed of differently graded aggregate, fine grading of the lower layer will not be required.

Each layer of aggregate shall be placed over the full width of the section except, the Engineer may authorize the Contractor to place less than full width layers, when existing traffic or other conditions restrict operations over the full width of the section. When the Contractor places material to complete the full width, the exposed edge of the previously placed aggregate shall be cleaned of all contamination before additional base or subbase aggregate is placed adjacent to it.

Aggregate base and subbase courses may be placed upon frozen surfaces when such surfaces have been properly constructed.

The material as spread shall be well mixed with no pockets of either fine or coarse material. Segregation of large or fine particles will not be allowed.

304.04 Shaping, Compacting and Stabilizing. Compaction of each layer shall continue until a density of not less than 95 percent of the maximum density has been achieved for the full width and depth of the layer. The maximum density shall be determined in accordance with AASHTO T180, Method C or D, corrected by the Soils Laboratory Adjustment Chart available at the MDOT Central Laboratory Bangor, Maine. Field density tests will be made by the Department. The surface, compaction and stability, shall be satisfactorily maintained until the pavement course has been placed. If required, additional water and fine material shall be applied to prevent checking, raveling or rutting.

Fine material added to the base shall be uniformly blended into the top 225 mm [9 inches] of the course being stabilized. The blended material shall meet the requirements of Subsection 304.02.

If the top of any layer becomes contaminated by degradation of the aggregate or addition of foreign material, the contaminated material shall be removed and replaced with the specified material.

All layers of aggregate subbase course shall be compacted to the required density immediately after placing. As soon as the compaction of any layer has been completed, the next layer shall be placed unless otherwise authorized.

The Contractor shall bear full responsibility for and make all necessary repairs to the subbase course and the subgrade until the full depth of the subbase course is placed and compacted. Repairs shall be considered incidental to other contract items.

The top of any aggregate base or subbase course layer shall be scarified and loosened for a minimum depth of 25 mm [1 inch] immediately prior to the placing of the next layer of aggregate base or subbase. This scarifying shall be considered incidental to placing the course, and no separate payment will be made.

The surface of each layer shall be maintained during compaction operations in such a manner that a uniform texture is produced and the aggregate firmly keyed. The moisture content of the material shall be maintained at the proper percent to attain the required compaction and stability.

If voids remain on the surface after the subbase course has been constructed to grade, compacted, checked and approved, sand leveling material shall be dumped and spread as directed. The quantity of sand levelling material shall be limited to the amount necessary to fill the voids and the minor low areas on the subbase surface. After the sand levelling material has been spread, it shall be completely rolled by a rubber tired roller with water applied, if necessary. The surface of this material shall be maintained in its compacted and graded condition until the bituminous pavement has been placed. The furnishing, spreading, compacting and maintaining of sand levelling material will be considered included in the measurement and payment of the subbase course and no separate payment will be made.

304.05 Surface Tolerance. The completed surface of the subbase or base course shall be shaped and maintained to a tolerance, above or below the required cross sectional shape, of 10 mm [3/8 inch].

304.06 Method of Measurement. Except as otherwise provided, aggregate base course and aggregate subbase to the level of subgrade will be measured by the cubic meter [cubic inches] in place unless designated by pay item to be measured by truck measure. When measured in place, the width and thickness for measurement will be the width and thickness of aggregate base or subbase as shown on the plans or as modified. The length will be along the centerline unless modified by other methods generally recognized as conforming to good engineering practice. All measurements will be in accordance with Section 109 -- Measurement and Payment. When designated by pay item to be measured by truck measure, the measurement will be in vehicles at the point of delivery as shown on delivery slips in accordance with Subsection 109.01(f).

As an alternative to in-place measurement, the Contractor and the Engineer may agree in writing that the quantities of aggregate base and subbase for payment will be that shown in the Schedule of Items. If such an agreement is reached, no further measuring and computing of quantities will be required and the quantity referred to herein will be final.

Aggregate base course and aggregate subbase course designated by pay item to be measured in place and used for driveways and other locations difficult to accurately measure in place, may be measured in vehicles at 80 percent of the number of cubic meters [cubic yards] accepted and used, at the point of delivery as shown by "Delivery Slips" in accordance with Subsection 109.01(f). The quantity so measured shall not exceed 1 000 m³ [1,000 cubic yards] per contract, after shrinkage.

304.07 Basis of Payment. The accepted quantities of aggregate base course and aggregate subbase course of the type specified will be paid for at the respective contract unit price per cubic meter [cubic inches].

When aggregate is required for slope blanket backfill, bedding under drainage structures and other foundations, it shall be paid for at twice the contract unit price for the respective aggregate base or subbase course item used.

Payment for aggregate base and subbase courses shall be full compensation for purchasing material, stripping pits, excavating, crushing, screening, hauling, placing, compacting and other necessary processes which are required to furnish acceptable material under this item.

Water and/or fines added to material to aid compaction and stabilization to prevent raveling and rutting shall be incidental to the work.

Removal and replacement of contaminated material shall be incidental to the work.

Materials which do not meet the gradation requirements for Aggregate Base or Aggregate Subbase at the time of placing will not be paid for under Aggregate Base or Aggregate Subbase Pay Item.

The quantity for payment of aggregate subbase or aggregate base placed on rock subgrade shall include only that material placed above the normal subgrade line. Furnishing and placing aggregate subbase or aggregate base backfill material between the rock and the normal subgrade line will not be paid for directly but shall be considered incidental to the work.

Payment will be made under:

Pay Item	Pay Unit
304.08 Aggregate Base Course-Screened	cubic meter [Cubic Yard]
304.083 Aggregate Base Course-Screened, Truck Measure	cubic meter [Cubic Yard]
304.09 Aggregate Base Course-Crushed	cubic meter [Cubic Yard]
304.093 Aggregate Base Course-Crushed, Truck Measure	cubic meter [Cubic Yard]
304.10 Aggregate Subbase Course- Gravel	cubic meter [Cubic Yard]
304.103 Aggregate Subbase Course-Gravel, Truck Measure	cubic meter [Cubic Yard]
304.11 Aggregate Subbase Course-Granular	cubic meter [Cubic Yard]
304.113 Aggregate Subbase Course-Granular, Truck Measure	cubic meter [Cubic Yard]
304.12 Aggregate Subbase Course-Sand	cubic meter [Cubic Yard]
304.123 Aggregate Subbase Course-Sand, Truck Measure	cubic meter [Cubic Yard]

SECTION 305 -- PREMIXED BITUMINOUS BASE

305.01 Description. This work shall consist of furnishing and placing premixed aggregate and bituminous material mixed either by the road mix method on an approved base or by a mixing plant. The bituminous mixture shall then be placed on an approved base or subbase 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.

MATERIALS

305.02 Bituminous Material. The type and grade of bituminous material will be specified in the contract documents. The bituminous material furnished shall meet the applicable requirements of Section 702 -- Bituminous Materials or as otherwise specified.

Bituminous material may be conditionally accepted at the source.

305.03 Aggregate. Aggregates shall meet the requirements of Subsection 703.04 and the gradations specified in Subsection 703.11, Gradation A immediately preceding the addition of bituminous material to the mix. This acceptance will be based on tests of samples of the stockpiles after all aggregates have been blended.

CONSTRUCTION REQUIREMENTS

305.041 Weather Limitations. No material shall be mixed between September 15 and May 1, unless the aggregates are heated and dried as directed during the mixing process. The heated mixture may be used directly from the plant without stockpiling, but if stockpiled, the mixture shall be protected from moisture. When placing mixture after September 15th, the mixture shall be premixed and stockpiled prior to September 15th. Necessary changes in the bituminous material to permit prolonged stockpiling shall be provided so that the mixture can be readily handled and placed during fall weather. Mixture placed after September 15th

may be placed upon frozen base when the base has been properly constructed. Mixture may be placed after September 15th only if the air temperature is above -1 °C [30 °F].

305.042 Equipment. The equipment used by the Contractor shall include mixing, spreading, finishing and compacting equipment, a bituminous distributor and equipment for heating bituminous material.

The bituminous distributor shall be designed, equipped, maintained and operated so that bituminous material at constant temperature may be applied uniformly on variable widths of surface up to 4.5 m [15 feet] at readily determined and controlled rates from 0.2 to 9 L/m² [0.05 to 2.0 gallons per square inches], with uniform pressure, and with an allowable variation from any specified rate not exceeding 0.10 L/m² [0.02 gallon per square inches]. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank and a thermometer for measuring temperatures of tank contents. Distributors shall also be equipped with a power unit for the pump and full circulation spray bars adjustable laterally and vertically.

All liquid and cement bituminous material bulk delivery vehicles and distributors shall be equipped with an acceptable sampling valve. On bulk delivery vehicles the valve shall be located in an accessible area in the lower half of the front or rear bulk head. The valve shall be similarly located on distributors, except that the valve may be installed in a circulating line having a rising flow.

Instead of road-mixing equipment, stationary mixing plants or other methods of proven performance may be used by the Contractor. The mixing plant shall include an aggregate charging bin capable of volumetric proportioning of the aggregate. The plant shall be equipped with an asphalt pump and metering system. The plant shall be capable of producing a uniform mixture with a minimum of segregation.

Rollers for premixed bituminous base shall be as specified in Subsection 401.11.

305.043 Mixing. The materials shall be premixed and stockpiled in an approved manner at approved locations. A stockpile sufficient to cover the area required for at least 2 days construction shall be maintained.

Mixed material to be used after September 15 shall be mixed prior to that date and shall be protected from moisture. The Contractor may elect to use a mixing plant or the road mix method on an approved surface or other approved methods and equipment that will produce the specified results.

When premixed bituminous base is mixed in a mixing plant the surface moisture of the aggregate shall in no case exceed 2 percent of the dry weight of the aggregate during mixing.

At the Contractor's option, a mixture conforming to the requirements of Section 301 may be used. If this option is exercised, the aggregate gradation and type of bituminous material, content and viscosity shall be as directed.

305.044 Spreading, Compacting and Finishing. The premixed materials shall be uniformly spread in the required amount by self-propelled mechanical spreaders, bituminous pavers or other approved mechanical spreading devices. Power graders for the initial placement of the premixed materials will not be permitted.

Regardless of which method of premixing is used, the liquid content (water, volatiles and bituminous material) shall be low enough so that the mixture can be properly compacted on the roadway.

After the material is placed, the surface shall be rolled. Rolling shall be parallel to the road centerline and shall commence at the outer edges of the road, overlapping the shoulders and progressing toward the center, overlapping on successive passes, except that on superelevated curves rolling shall progress from the lower to the upper edge.

Each pass shall terminate at least 1 m [3 feet] in advance or to the rear of the end of the preceding pass. During the compaction the surface shall be dragged or bladed as necessary to fill ruts and to remove corrugations or other irregularities. Rolling shall continue until the surfacing is of uniform texture and satisfactory compaction is obtained. Initial rolling shall be performed with a steel wheel roller followed with a pneumatic tire roller. Rolling shall be discontinued whenever it begins to produce excessive pulverizing of the aggregate or displacement of the mixture. Rolling shall be completed before any section is opened to public traffic.

305.05 Surface Requirements. The completed surface of the designated course shall be shaped to a tolerance of 10 mm [3/8 inch] above or below the required cross sectional shape.

305.06 Method of Measurement. Premixed Bituminous Base will be measured by the cubic meter [cubic inches] in place measure or by the megagram [ton] with a conversion factor of 2.35 Mg/m³ cubic meter [1.98 tons per cubic inches] used with weigh delivery slips in accordance with Section 109 -- Measurement and Payment.

305.07 Basis of Payment. The accepted quantities of premixed bituminous base course will be paid for at the contract unit price per cubic meter [cubic yard] for the mixture, including aggregates and bituminous material, complete in place.

Payment will be made under:

Pay Item	Pay Unit
305.10 Premixed Bituminous Base Course	cubic meter [Cubic Yard]

SECTION 306 -- RECLAIMED MATERIAL FOR STABILIZED BASE

Reserved

SECTION 307 -- COLD IN-PLACE RECYCLED PAVEMENT

SECTION 308 -- BASE STABILIZATION

Reserved

SECTION 309 -- VACANT

SECTION 310 -- BITUMINOUS STABILIZED BASE

310.01 Description. This work shall consist of furnishing aggregate mixed with bituminous material and placed on an approved surface 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.

MATERIALS

310.02 Mixtures. The mixture of aggregates and residual bitumen shall have a Hveem stability of at least 25 when tested according to AASHTO T246. Test specimens will be prepared according to AASHTO T247. Compaction temperature for all mixtures containing emulsified asphalt shall be 60 °C [140 °F].

310.03 Bituminous Materials. Either asphalt cement or a mixing grade emulsion shall be used. The method of mixing shall determine the type of bituminous material. The grade shall be as specified in the contract. The bituminous material shall meet the applicable requirements of Section 702 -- Bituminous Materials.

Bituminous materials may be conditionally accepted at the source.

310.04 Aggregates. Aggregates shall meet the requirements of Subsection 703.17 before the addition of the bituminous materials.

CONSTRUCTION REQUIREMENTS

310.05 General. The materials for bituminous stabilized base shall be mixed and placed according to the Construction Requirements of Section 301 -- Plant Mix Bituminous Base Course. The bitumen content will be determined by the Engineer.

When the base course is placed in two or more layers, each layer, except the top of the last layer, shall be coated with approximately 0.10 L/m² [0.02 gallons per square inches] of

emulsified asphalt. The maximum thickness of a single layer of base course material shall not exceed 75 mm [3 inches] when compacted.

310.06 Weather Limitations. The plant mix bituminous stabilized base course shall be placed in conformity with Subsection 401.07. Mixing operations using emulsified asphalt may be permitted after September 15 provided the air temperature is 4 °C [40 °F] or above and a heated mixture at 55 °C-105 °C [130 °F-220 °F] is discharged from the plant.

310.07 Compaction. Whether a heated or cold mix method is used, the minimum dry compaction requirement for the bituminous stabilized base course will be 92 percent of the laboratory density specimen compacted to meet the requirements specified in Subsection 310.02. The residual bitumen will be included as part of the unit dry weight.

310.08 Surface Tolerance. The base course surface will be tested with a 3 m [10 foot] straightedge. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall at no point exceed 6 mm [$\frac{1}{4}$ inch]. All humps or depressions exceeding the specified tolerances shall be eliminated. The straightedge shall be furnished by the Contractor.

310.09 Method of Measurement. Plant mix bituminous stabilized base will be measured by the megagram [ton] in accordance with Subsection 401.21. No separate measurement of the bituminous material will be made.

310.10 Basis of Payment. The accepted quantity of plant mixed bituminous stabilized base will be paid for at the contract unit price per megagram [ton] for the bituminous mixture, including bituminous material complete in place.

Payment will be made under:

Pay Item	Pay Unit
310.13 Plant Mix Bituminous Stabilized Base	megagram [Ton]

DIVISION 400 -- PAVEMENTS

SECTION 401 -- PLANT MIX PAVEMENTS -- GENERAL

401.01 Description. This work shall consist of furnishing and placing one or more courses of bituminous mixture on an approved base in accordance with these specifications and the specific requirements of the type of mixture under contract and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established.

MATERIALS

401.02 Composition of Mixtures. The bituminous plant mixture shall be composed of aggregate, filler, if required, and bituminous material. The several aggregate fractions shall be sized, uniformly graded and combined in proportions that will provide a mixture meeting the grading requirements of the job mix formula. A maximum of 20 percent reclaimed asphalt pavement may be used in all binder and plant mixed base courses and a maximum of 20 percent reclaimed asphalt pavement may be used in the wearing course placed on shoulders only.

The Contractor shall submit for approval, a job mix formula for each mixture to be supplied. The job mix formula shall be used to establish a single percentage of aggregate passing each required sieve size which, with the allowable tolerances given, shall be within the master gradation range specified for the particular type of mixture. It shall state the source, gradation and percentage to be used of each portion of the aggregate, and filler, if required. It shall also state the name and the location of the refiner and the supplier for each source of the bituminous material submitted for approval.

At the time the job mix formula is submitted, the Contractor shall indicate and make available for sampling and testing at the plant site, the stockpiles of all aggregates proposed for use. A minimum of 10 days shall then be allowed for testing prior to approval of the job mix formula.

Upon approval of the mix, the Engineer will establish, as a part of the job mix formula, a percentage of residual bituminous material for the mixture, and temperatures for the mixture at the two points of discharge. Should the kinematic viscosity of the proposed bituminous material(s) at 135 °C [275°F] be found to vary by more than 50 centistokes, different mixing temperatures may be established. A notation shall be made for each new bituminous material added to a job mix formula already approved, showing the material source and the adjusted mixing temperature, if necessary. The bitumen content aim, including the allowable tolerance, shall be within the range as shown in the Special Provisions or on the plans.

After the job mix formula is established, the components and temperatures of the mixture shall conform within the following tolerances, except that no gradation tolerance will be applied to Grading "E" mixture for which the gradation shall be within the limits given in Subsection 703.09:

Aggregate portion of mix: Sieve Sizes	Tolerance (Percent)

Passing 50 mm to 19 mm	[2 inch to 3/4 inch]	±10
Passing 12.5 mm to 4.75 mm	[1/2 inch to Number 4]	±7
Passing 2.36 mm	[Number 8]	±6
Passing 1.18 mm	[Number 16]	±5
Passing 600 µm to 300 µm	[No. 30 to No. 50]	±4
Passing 150 µm	[Number 100]	±3
Passing 75 µm	[Number 200]	±2

Bituminous Material

Percent of mixture	+0.4 percent, -0.2 percent

Temperature of Mix - All gradings

In the truck at the mixing plant	±10 °C (±20 °F)
At the paver	±10 °C (±20 °F), but also to maximum plant temperature

The asphalt concrete mixtures with the exception of Grading "E", shall conform to a minimum stability requirement of 25 when tested according to AASHTO T246.

If there is a change in sources of aggregates or filler, a new job mix formula shall be established before the new material is used. When unsatisfactory results or other conditions make it necessary, a new job mix formula may be established.

401.03 Aggregates. Aggregates shall meet the applicable requirements of Section 703 -- Aggregates, in the stockpiles at the plant site.

401.04 and 401.05 Vacant

401.06 Bituminous Materials. The type and grade of bituminous material will be specified in the contract. The bituminous material shall meet the applicable requirements of Section 702 -- Bituminous Materials and may be conditionally accepted at the source.

CONSTRUCTION REQUIREMENTS

401.07 Weather and Seasonal Limitations. For weather limitations the State will be considered to be divided into 2 paving zones:

- (a) Zone 1. All area north of US Route 2 from Gilead to Bangor and north of Route 9 from Bangor to Calais.
- (b) Zone 2. All area south of Zone 1 including the US Route 2 and Route 9 boundaries.

Bituminous plant mix for use other than traveled way wearing course may be placed in either zone between the dates of April 15th and November 15th, provided that the air temperature as determined by an approved thermometer placed in the shade at the paving location is 2 °C [35 °F] or higher and the area to be paved is not frozen. Plant mix to be placed as traveled way wearing course may be placed in Zone 1 between the dates of May 1st and the Saturday following October 1st and in Zone 2 between the dates of April 15th and the Saturday following October 15th provided the air temperature determined as above is 10 °C [50 °F] or higher. The traveled way as used herein shall also include truck lanes, ramps, approach roads and auxiliary lanes.

Any hot bituminous base or binder course that is to be subjected to traffic during the winter months shall have its gradation densified or asphalt content (percent of mix) adjusted through a change in the job mix formula as submitted by the Contractor and approved by the Engineer.

Hot bituminous mixtures used for curb, driveways, sidewalks, islands or other incidentals are not subject to seasonal limitations, except that weather conditions shall be satisfactory for proper handling and finishing of the mixture. Unless otherwise specified, bituminous plant mix shall not be placed on a wet surface or a frozen surface. The air temperature shall be 2 °C [35 °F] or higher.

When it is in the public interest for service to traffic, the Department may authorize construction of bituminous pavements at lower atmospheric temperatures than those specified or extend the dates of the paving season.

401.08 Bituminous Mixing Plant.

401.081 General Requirements. Mixing plants shall be of sufficient capacity and be coordinated to adequately handle the proposed bituminous construction.

- (a) Aggregate Storage. Sufficient storage space shall be provided for uniform stockpiles of various sized or blended aggregates which shall be kept separate until they have been introduced into the cold feed bins.

The storage yard shall be maintained in a neat and orderly manner. The separate stockpiles shall be readily accessible for sampling.

The stockpile floor shall be firm, smooth, well-drained and shall be of reasonably uniform cross section and capable of supporting the stockpile and equipment. A bed of aggregate suitable to prevent the intrusion of foreign material shall be maintained. Sufficient material must be produced and stockpiled prior to starting construction operations to permit proper sampling and testing of the material before it is used.

The following minimum amounts of material must be available for sampling and testing.

1. Crushed Stone 150 mg [150 Tons]
2. Sand 75 mg [75 tons]
3. Blend Sand 50 mg [50 Tons]

For production, a sufficient quantity of stockpiled material shall be maintained for at least two days production, except on the last two days of production. A days production is defined as follows:

Drum Plant: $90\% \text{ of rated capacity megagrams per hour [TPH]} \times 8 \text{ hours}$
less the asphalt content.

Batch Plant: $\text{rated batch size in megagrams [tons]} \times 60 \text{ batches per hour} \times 8 \text{ hours}$
less the asphalt content.

These equations are to be used as guidelines. The acceptable stockpile size shall be determined by the Engineer.

The stockpiles shall be built in a manner which will prevent separation of aggregate sizes. Care shall be taken not to deposit foreign material during the building of the stockpiles. The equipment used to level or form the piles shall not cause breakdown of the aggregate sizes.

Aggregate producer's stockpiling methods currently in use and proven satisfactory to the Engineer may be continued at the source.

Stockpiles containing excessive segregation or degradation as determined by the Engineer may be tested by sieve analysis from samples taken at any portion of the stockpile. The mix will be unacceptable if a change in any stockpile produces a variation on any sieve size of greater than ten percent from that indicated on the job mix formula. The mix will also be unacceptable if a change in cold feed settings produces a change in stockpile percentages of greater than ten percent from that indicated on the approved job mix formula.

The cold feed bins shall not be charged with aggregates coming directly from crushing or screening plants or combination of these plants, unless the stockpile is being formed from the conveyor in a satisfactory manner.

Regardless of the method of storage and handling, all aggregates which are segregated, degraded, or contaminated to the extent that they do not meet specifications will be unacceptable; however, the stockpile may be reconditioned by any method which produces satisfactory material.

- (b) Cold Bins. A minimum of 4 cold bins will be required. The bin dimensions shall be such as to promote free flow of material. Partitions shall be sufficiently high to eliminate overflow of aggregate into adjacent bins. If a front end loader is being used to load, the dumping width of the loader bucket shall be no wider than the width of the top of the bins.
- (c) Bitumen Storage. Tanks for the storage of bituminous material shall be equipped to heat and circulate the material at the required temperature. The heating shall be accomplished by steam coils, electricity or other approved means so that no flame will be in contact with the tank. The circulation system for the bituminous material shall be designed to assure proper and continuous circulation during the operating period. The return line to the storage tank shall extend to the lower portion of the tank to prevent free fall. Provisions shall also be made for measuring the amount of material in storage tanks.

A valve for sampling the bituminous material shall be provided and located in a circulating feed line connecting the storage tank with the mixing plant or in a line of the storage circulation system. The valve shall be placed in a readily accessible location offering protection from damage and shall be maintained in a workable condition. A drainage receptacle shall be provided.
- (d) Feeder for Drier. The plant shall be provided with accurate mechanical means for uniformly feeding the aggregate into the drier to provide uniform production and temperature.
- (e) Drier. The plant shall include a drier or driers which continuously agitate the aggregate during the heating and drying process.
- (f) Truck Scales. When the bituminous mixture is weighed on scales meeting the requirements of Section 109 -- Measurement and Payment, the scales shall be inspected and sealed by the State Sealer as often as the Engineer deems necessary to assure their accuracy.
- (g) Safety Requirements. Adequate and safe stairways to the mixer platform and sampling points shall be provided and guarded ladders to other plant units shall be placed at points where accessibility to plant operations is required. Accessibility to the top of truck bodies shall be provided by a platform or other suitable device placed in an acceptable location near the testing laboratory to enable the Engineer to obtain samples and mix temperature data.

Ample and unobstructed space shall be provided on the mixing platform. A clear and unobstructed passage shall be maintained at all times in and around the truck loading area. This area shall be kept free from drippings from the mixing platform.

- (h) Hot Mix Storage Bins. The hot storage system shall be capable of conveying the hot mix from the plant to insulated storage bins and storing the hot mix without a loss in temperature, segregation of the mix or oxidation of the mix. Storage duration time shall be limited by the ability of the bins to maintain the hot mix so that, upon delivery to the spreader, the temperature will be not less than the minimum temperature stated on the job mix formula. The storage bins shall be designed to prevent segregation of the hot-mix during discharge from the conveyor into the bins and shall be equipped with discharge gates that will not cause segregation of the hot-mix while loading the mix into the trucks. The storage bin heating system shall be capable of maintaining the mix temperature without localized heating (hot spots).

Unless an approved storage bin or silo is used the material must be drawn during the same working day. When a storage bin or silo is approved the material may be held overnight, but not more than 24 hours. Approval will be determined by the ability of the bin or silo to maintain a uniform temperature and has the ability to be sealed at the top and bottom.

Approval for the use of storage bins may be withdrawn in event there is an excessive amount of heat loss, segregation and/or oxidation of the hot mix due to the use of storage bins.

401.082 Requirements for Batch Plants.

- (a) Screens. Plant screens capable of screening all aggregates to the specified sizes and proportions and having normal capacities in excess of the full capacity of the mixer shall be provided. The screen deck shall have a tailing pipe of sufficient size to prevent oversize material from entering the bins.
- (b) Hot Bins. The plant shall have hot storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. The bins shall be arranged to assure separate storage of appropriate fractions of the mineral aggregate. Each bin shall be provided with overflow pipes with outlets of sufficient size located so as to prevent backup of aggregate material into other compartments or bins. The overflow outlet pipes shall be open at all times during plant operations. Each bin shall be provided with its individual outlet gate which shall be capable of quick and complete cut-off.

The bins shall be equipped with adequate telltale devices to automatically indicate the position of the aggregates in the bins at the lower quarter points.

The bins shall also be constructed so that samples of aggregates may be easily taken.

When required, separate dry storage shall be provided for filler or hydrated lime with provisions to feed this material into the mixer.

- (c) Weigh Box or Hopper. The batch plant equipment shall include a means for accurately weighing each size of aggregate in a weigh box or hopper suspended on scales and of ample size to hold a full batch without hand raking or running over. The gate shall close tightly so that no material leaks into the mixer while a batch is being weighed.
- (d) Bituminous Control Unit. Satisfactory means shall be provided either by weighing or by metering to obtain the proper quantity of bituminous material in the mix within the tolerances specified. Means shall also be provided for checking the quantity or rate of flow of bituminous material as it passes into the mixer.

When a metering system is used to measure the bituminous material it shall be accurate to plus or minus 0.1 percent of nominal batch size. In the event of malfunction of the system, the Contractor may provide a calibration chart for the indicator of the metering device which will show the quantity of material delivered at each setting. Production using such a chart may be continued for a period not to exceed the next 48 hours.

The bucket for bituminous material shall be a non-tilting type bucket with a capacity of at least 15 percent greater than the bituminous material required in any batch. Its discharge valve or valves and spray bar shall be adequately heated. If steam jackets are used they shall drain efficiently and all connections constructed so as not to interfere with the operation of the bituminous scales. A heated quick-acting, non-drip charging valve shall be located as close to the bucket as practical.

The length of the discharge openings or spray bar shall deliver the bituminous material in a thin uniform sheet or in multiple streams over the full length or width of the mixer. The flow of bituminous material shall be automatically controlled so that it will begin when the dry mixing period is over.

The controls shall be constructed so that they may be set at any dial setting and will automatically reset to that dial setting after addition of bituminous material to each batch. All dials shall be in full view of the plant batching operator. The indicator dial shall have a capacity of at least 15 percent in excess of the quantity of bituminous material used in a batch.

The section of the bituminous line between the charging valve and the spray bar shall be provided with a valve and outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

- (e) Thermometric Equipment. An armored thermometer of adequate temperature range shall be affixed to the bituminous feed line at a location near the charging valve at the mixer unit. The plant shall also be equipped with either an approved dial scale, mercury actuated thermometer, electric pyrometer or other approved thermometric instrument so placed at the discharge chute of the drier to register automatically or indicate the temperature of the heated aggregates.

The hot bin containing fine aggregate shall be equipped with a thermometer or other approved thermometric instrument to indicate the temperature of the heated aggregate immediately before it enters the mixer. The dial or other indicator shall be plainly visible and readable from a platform or control room.

- (f) Mixer. The batch mixer shall be an approved type capable of producing a uniform mixture within the job mix tolerances.

The clearance of the blades from the inner surface of the pugmill liner shall not exceed 25 mm [1 inch] unless the maximum diameter of the aggregate in the mix exceeds 31.5 mm [$1\frac{1}{4}$ inches], in which case the clearance shall not exceed 37.5 mm [$1\frac{1}{2}$ inches].

- (g) Control of Mixing Time. The mixer shall be equipped with an automatic accurate time lock to control the operations of a complete mixing cycle. It shall lock the weigh box gate after charging the mixer until the closing of the mixer gate at the completion of the cycle. It shall also lock the bituminous material bucket throughout the dry the dry mixing period and the mixer gate throughout the dry and wet mixing periods. The control of the timing shall be flexible and capable of being set at intervals of 5 seconds or less throughout a total mixing cycle. The dry mixing period is defined as the interval of time between the opening of the weigh box gate and the start of introduction of bituminous material.

The wet mixing period is defined as the interval of time between the start of introduction of bituminous material and the opening of the mixer gate.

A mechanical or electronic batch counter shall be installed as a part of the timing device and shall be designed to register only completely mixed batches. The setting of the time intervals shall be performed in the presence and at the direction of the Engineer.

- (h) Plant Scales. Plant scales shall meet the following requirements:

Aggregate Scales

Minimum Graduations	=	(Batch Size) x .0025
Sensitivity	=	(Batch Size) x .00125
Accuracy	=	(Batch Size) x .005

Asphalt Scales

Minimum Graduations	=	(Batch Size) x .0005
Sensitivity	=	(Batch Size) x .00025
Accuracy	=	(Batch Size) x .001

Poises shall be designed to be locked in any position to prevent unauthorized change of position.

Plant scales shall be checked prior to the start of the paving season. Subsequent checks will be made if the Engineer deems it necessary to ensure continued accuracy. The Contractor shall have on hand not less than ten 25 kg masses* [ten fifty pound weights] for testing of the scales.

- (i) Dust Collector. The plant shall be equipped with a dust collector constructed to waste or return uniformly to the hot elevator all or any part of the material collected.

*The Contractor may continue to use the present 22.68 kg masses [50 pound weights] as long as they remain serviceable. If new masses are needed, a set of ten 25 kg masses shall be supplied.

401.083 Automation of Batching. All batch plants shall be required to be automated to the point where the weighing, recycling and monitoring system shall be utilized unless the project requires less than 1000 Mg [1,000 tons]. In the case of a breakdown of the printing system the requirements of Subsection 109.013C will apply.

The system shall include components for accurately proportioning the various materials for the mixture in the proper order by weight. The entire batching and mixing cycle shall be continuous and shall not require any manual operations. There shall be auxiliary interlock circuits to trigger an audible alarm, whenever an error exceeding the acceptable tolerance occurs. Also, along with the alarm, the printer shall print an asterisk on the delivery slip. The asterisk shall be placed beside the out-of-tolerance weight or either at the beginning or end of the row containing the out-of-tolerance weight. The automatic proportioning system shall be capable of consistently delivering material within the full range of batch sizes.

All tolerances are based on the total batch weight of the bituminous mix. The system shall be able to automatically or manually adjust for all desired batch sizes. The first or last bin drawn shall be the sand bin. The following shall be the allowable tolerances:

Each aggregate component	±2.5 percent from the cumulative target, each bin
Last Bin Drawn	±1.5 percent
Mineral Filler	±0.5 percent
Bituminous Material	-.15, +.25 percent
Zero Return (aggr)	±0.5 percent

Zero Return (bit. material)

±0.1 percent

All plants shall be equipped with an approved digital recording device. The delivery slip load ticket shall contain information required under Section 109.01(f), 1 to 4 and 109.012,(a) and (b).

401.084 Requirements for Continuous Drum Type Mixing Plants. The continuous drum type mixing plant shall consist of a drier capable of drying, heating and mixing the aggregate to the temperature requirements established in the job mix formula. This type mixer shall also conform to the following specifications:

- (a) Cold Feed System. The plant shall have a device at each cold bin to feed the aggregate accurately and uniformly. Gravity type feeders will not be permitted.

Each adjustable opening shall be provided with indicators graduated to allow proportioning. Each aggregate feeder shall be interlocked in such a manner that production is interrupted if one or more cold bins become empty or the flow is obstructed. A mineral filler bin, when required, shall be added to the standard plant cold feed bins and shall feed the mineral filler at adjustable rates accurately and uniformly. The feeder shall be interlocked so that production is interrupted if the bin becomes empty or the flow is obstructed.

The aggregate weighing equipment for all aggregates, including mineral filler, shall consist of a continuous weighing device either as it is proportioned by the individual feeders or after all materials have been deposited on a common belt. Belt scales shall meet the requirements of NIST Handbook 44 and shall be installed according to the scale manufacturers recommendations.

The plant shall have an adjustable feed rate control for each aggregate cold bin feeder and mineral filler feeder. The plant shall proportion the total aggregate quantity to the drum mixer with such accuracy and uniformity that the variation of material per interval of time shall not exceed an amount equal to 1.5 percent of the total weight of bituminous mixture per interval of time.

An automatic aggregate sampling device shall be provided which will divert a representative combined aggregate sample, including mineral filler, into a hopper or container for the purpose of gradation testing. The container shall cut the full width and depth of the aggregate flow. The sampling point shall be after the aggregate is proportioned and prior to its mixing with bitumen.

- (b) Bituminous Control Unit. The bitumen shall be proportioned by a meter accurate to 0.1 percent based on the total bituminous mixture. A flow switch, designed to interrupt production if the bitumen flow is discontinued, shall be installed in the delivery line between the meter and the mixer.

The bitumen delivery system shall be coupled with the aggregate delivery system to automatically maintain the required proportions as the aggregate flow varies.

The delivery tolerance for bitumen shall be ± 0.2 percent of the total mixture weight.

The bitumen feed line shall be equipped with a thermometer and an approved bitumen sampling valve.

- (c) **Mixer Unit.** The plant shall include a continuous mixer unit having an automatic burner control and capable of producing a uniform mixture within the Job Mix Tolerances. The mixture shall be discharged into a hot bituminous mixture holding bin meeting the requirements of Subsection 401.081(h) Hot Bituminous Mixture Holding Bins. The moisture content of the mixture upon discharge from the mixer shall not exceed 1.5 percent by weight.
- (d) **Hot Bituminous Mixture Holding Bin.** Hot bituminous mixtures may be stored in holding bins, especially designed for that purpose. Each holding bin shall be inspected by the Department to determine acceptance at specific holding times. Acceptance will be based upon the ability of the holding bin to hold and discharge mixtures within the quality criteria specified in the job mix formula.

401.085 Drum Plant Recordation of Proportions. The plant shall be equipped with a recordation system and it shall be utilized unless the project requires less than 5000 Mg [5,000 Tons]. In the case of a malfunction of this recordation system, two working days will be allowed for the system to be repaired before shutdown will be required. The recorder shall be capable of simultaneously recording the accumulated weights of the dry aggregates, the mineral filler if added separately and the bitumen, all at 5 minute intervals during production and on demand, or by another method approved by the Engineer. The printed record shall include the actual bitumen content quantity as a percentage of the total mixture weight. The maximum resolution shall be 90 kg [0.1 Tons] of dry aggregate, 9 kg [0.01 Tons] of mineral filler if added separately, 9 kg [0.01 Tons] of bitumen, and 0.1 percent for bitumen content. The printout shall indicate the amount of moisture programmed into the moisture compensation by total weight. All printed records shall show the day, month, year and the time to the nearest minute when the printout was generated. The Engineer shall be provided with a clear and legible copy of the recordings at the end of each day.

- (a) **Production Rate.** Allowable production rates will be determined for each plant. The maximum megagrams per hour rating [tons per hour rating (T.P.H.)] will be established by the manufacturers' rating of their belt scales. The minimum production rate will be 35 percent of the maximum rating.
- (b) **Production Rate Change.** When the production rate is adjusted, a single control shall be capable of increasing or decreasing all feed rates simultaneously.

401.09 Hauling Equipment. Trucks for hauling bituminous mixtures shall have tight, clean, smooth metal bodies which have been thinly coated with a small amount of lime solution or an approved soap solution or detergent to prevent the mixture from adhering to the bodies.

All trucks shall have a cover of canvas or other water repellent material capable of heat retention and of such size to completely cover the mixture. The cover shall be securely fastened on the loaded truck at all times except when unloading.

When necessary, so that the mixture will be delivered to the project at the specified temperature, the truck body shall be adequately insulated. Trucks shall be loaded no later in the day than will allow completion of the spreading and compacting of the mixture during daylight hours.

All truck bodies shall have an opening on both sides which will accommodate a thermometer stem. The opening shall be located at the midpoint of the body, at least 300 mm [1 foot] above the bed.

401.10 Bituminous Pavers. Bituminous pavers shall be self-contained, self-propelled units, provided with an activated screed, heated if necessary and capable of spreading and finishing courses of bituminous plant mix material in lane widths to the specified typical section and thicknesses shown on the plans. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of bituminous plant mix material in widths shown on the plans.

The bituminous mixtures placed on the main line shall be placed by a paver equipped with an automatic grade and slope controlled screed, unless otherwise directed by the Engineer. The controls shall automatically adjust the screed and increase or decrease the layer thickness to compensate for irregularities in the preceding course. The controls shall be capable of maintaining the proper transverse slope and be readily adjustable so that transitions and superelevated curves can be properly paved. The controls shall be operated from a fixed or moving reference as directed.

Pavers with extendible screeds shall have auger extensions and tunnel extenders as necessary.

The paver shall have a receiving hopper with sufficient capacity for a uniform spreading operation and a distribution system to place the mixture uniformly and without segregation in front of the screed.

The screed assembly shall produce a finished surface of the required evenness and texture without tearing, shoving or gouging the mixture.

The paver shall be operated at speeds that produce a uniform mat.

Bituminous pavers shall be at the project site sufficiently ahead of the start of paving operations to be inspected and approved. Any paver found worn or defective either before or during its use shall be replaced or repaired to the satisfaction of the Engineer.

401.11 Rollers. Rollers shall be either static steel, or pneumatic tire or approved vibrator type. Rollers shall be in good mechanical condition, capable of starting and stopping smoothly

without jerking and also be free from backlash when reversing direction. They shall be equipped and operated in such a way as to prevent the picking up of hot mixed material by the tires or roller surface. Use of rollers which result in crushing of the aggregate or displacement of the mixture will not be permitted.

The maximum operating speed for a steel wheel roller shall not exceed 5 km/h [3 miles per hour].

On all main line courses, the rolling train shall be as follows: a vibratory roller or a two-axle steel wheel tandem roller for initial rolling, a pneumatic tire roller for intermediate rolling, and a two-axle or three-axle steel wheel tandem for finish rolling.

The minimum weight of any roller used in the rolling train shall be 7.25 Mg [8 tons]. All ballasting shall conform to the manufacturer's specifications.

Additional rollers may be required if the standard roller train is extended beyond its capacity to compact the mixture while it is still in a workable condition.

The Contractor shall furnish a weigh slip showing the actual weight for each roller to be used on the project.

401.111 Steel Wheel Rollers.

- (a) Two Axle Tandem Steel Wheel Rollers: Tandem steel wheel rollers shall have a manufacturer's rating of not less than 7.25 Mg [8 tons]. The surface of all rolls shall be smooth and free from defects which mar the finished road surface.
- (b) Three-Axle Tandem Steel Wheel Rollers: Three-axle tandem rollers shall have a manufacturer's rating of not less than 10.9 Mg [12 tons]. Three-axle tandem rollers shall be used as a finish roller. The rolls shall be in a locked position in one plane.
- (c) Vibratory Rollers: Vibratory rollers shall be the dual drum type specifically designed for bituminous compaction. The roller shall be equipped with a variable amplitude and frequency system. The roller shall be equipped with a speedometer and a vibrations-per-minute gauge.

The roller shall be equipped with a vibrator drive that automatically stops when the roller changes direction or stops. Rollers shall not be used in a vibratory mode on bridge decks. When used in the static mode the vibratory roller shall be considered a steel wheel roller.

Vibratory rollers shall be operated at low amplitude unless otherwise directed. Vibratory rollers shall meet the speed and frequency ranges shown in the following table:

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401.112 Pneumatic Tire Rollers. Pneumatic tire rollers shall be self-propelled, reversible units with vertical oscillation on all wheels on at least one axle. The tires on the front and rear axles shall have wide smooth treads and shall be staggered to provide complete coverage of the entire area over which the roller travels. The tires shall be of equal size and diameter, uniformly inflated and the tire pressure shall not vary by more than 35 kPa [5 pounds per square inch]. The maximum speed of the pneumatic-tired roller shall not exceed 8 km/h [5 miles per hour]. Rolling shall continue until the entire surface has been uniformly compacted.

The Contractor shall furnish tire manufacturer's charts or tabulations for verification of required inflation pressure by the Engineer. A suitable gauge for determining air pressure in tires shall be provided by the Contractor.

If excessive rutting of the mix by the rubber tire roller occurs, the Contractor shall adjust the tire pressure as required.

Pneumatic tire rollers for compacting bituminous pavements shall meet the minimum requirement of Type I or II, as follows:

Type No.	Minimum Tire Size	Load Per Wheel
I	750 x 15	900 kg [2000 lbs]
II	900 x 20	2250 kg [5000 lbs]

Type No. II will be required in the rolling train on all project unless otherwise specified.

CONSTRUCTION REQUIREMENTS

401.12 Conditioning of Existing Surface. The surface upon which bituminous mixture is to be placed shall be thoroughly cleaned of all objectionable material. When the surface of the existing base or pavement is irregular, it shall be brought to uniform grade and cross section as directed.

401.13 Bituminous Material Documentation. The Contractor shall determine with the Engineer the amount of bituminous material used each day on a specific contract.

401.14 Preparation of Aggregates. The aggregates for the mixture shall be dried and heated to the required temperature. Flames used for drying and heating shall be properly adjusted to avoid physical damage to the aggregate and to avoid depositing soot on the aggregate.

401.15 Mixing. The dried aggregates shall be combined in the mixer in the amount of each fraction of aggregate required to meet the job mix formula. The bituminous material shall be measured or gauged and introduced into the mixer in the amount specified by the job mix formula.

For hot bituminous pavement the mixture shall be produced at the temperature established by the job mix formula. This temperature will be determined and will be a temperature at which the viscosity of the bituminous material is between 150 and 300 centistokes.

The aggregate shall be sufficiently dried so that the mixture will not flush, foam excessively or displace excessively under the action of the rollers. It shall be introduced into the mixer at a temperature of not more than 14 °C [25 °F] above the temperature at which the viscosity of the bituminous material being used is 150 centistokes.

The bituminous material shall be stored and introduced into the mixer at a uniformly maintained temperature which shall be within the limits at which the viscosity of the material is between 150 and 300 centistokes.

After the required amounts of aggregate and bituminous material have been introduced into the mixer, unless otherwise specified, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is obtained. Wet mixing time will be determined by the Engineer for each plant and for each type of aggregate used.

401.16 Spreading and Finishing. The mixture shall be laid upon an approved surface, spread and struck off to the grade and elevation established. Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial width as may be practicable. During placing operations, sufficient bituminous mixture shall be delivered to the project to maintain a constant paving speed. The paver speed shall be adjusted to the plant production capabilities, regardless of haul distance.

Automatic screed control by means of the fixed reference will only be required when and to the extent stated in the Special Provisions. The moving reference shall consist of a manufacturer approved ski-type attachment or travelling string line, not less than 9 m [30 feet] in length, attached to the paver and operating parallel to its line of travel. A shoe or joint matcher, may be permitted to construct the joint on the last course of surface mixture. A 12 m [40 foot] ski shall be required on Interstate projects.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be spread, raked and luted with hand tools. For such areas the mixture shall be dumped, spread and screeded to give the required compacted thickness.

When production of the mixture can be maintained and when practical, pavers shall be used in echelon to place the course in adjacent lanes.

On roads opened to two way traffic, the placement of each course shall be completed over the full width of the traveled way section being paved on each day's run unless otherwise approved.

401.17 Compaction. Immediately after the bituminous mixture has been spread, struck off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.

The surface shall be rolled when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking, or shoving. To prevent adhesion of the mixture to the rollers or vibrating compactors, the rolls of contact surfaces shall be kept moistened with water or water mixed with small quantities of detergent, or other approved method. Oil will not be permitted.

Unless otherwise directed, rolling shall begin at the low side and proceed longitudinally parallel to the centerline, each trip overlapping the previously rolled strips, gradually progressing to the high side using a uniform rolling pattern that will insure complete coverage of the entire mat. When paving in echelon or abutting a previously placed lane, the longitudinal joint should be rolled first followed by the regular rolling procedure.

Rollers shall move at a slow uniform speed with the drive roll wheels nearest the paver. Rolling shall be continued until all roller markings are eliminated.

Any displacement occurring as a result of the reversing of the direction of a roller or from other causes, shall be corrected at once by the use of rakes or lutes and additional fresh mixture when required. Care shall be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture.

Along forms, curbs, headers, walls, and other places not accessible to the rollers, the mixture shall be thoroughly compacted with mechanical vibrating compactors. Hand tamping will be permitted only for areas inaccessible to other compaction equipment. On depressed areas, a trench

roller may be used or cleated compression strips may be used under the roller to transmit compression to the depressed area.

Mixture that becomes loose and broken, mixed with dirt or is in any way defective shall be removed and replaced with fresh, hot mixture, which shall be compacted to conform with the surrounding area. Mixture showing an excess or deficiency of bituminous material shall be removed and replaced.

401.18 Joints. Wearing course transverse joints shall be constructed using shims equal to the depth allowed for compaction.

The paver shall always maintain a uniform head of material during the joint construction. The bituminous mix shall be free of segregation and meet temperature requirements.

Transverse joints of the wearing course shall be straight and neatly trimmed. A vertical face exposing the full depth of the course may be formed by inserting a header, by breaking the bond with the underlying course or by cutting back with hand tools. Feathered or "lap" joints may be permitted on lower courses or when matching existing low type pavements.

Edges of joints that are to form longitudinal joints shall be maintained vertically.

A coating of emulsified asphalt shall be applied each day prior to paving to all joints except those formed by pavers operating in echelon. The application shall be by an approved spray apparatus designed for covering a narrow surface. Application of this material by a brush may be approved for small surfaces or in the event of a malfunction of the spray apparatus, but for a period of not more than one working day.

Where pavement under this contract joins an existing pavement, and when directed, the existing pavement shall be cut along a smooth line and to a neat, even vertical joint. Broken or raveled edges will not be permitted. All work necessary for the preparation of this joint will be considered as incidental to the related contract items.

401.19 Pavement Samples. Except as hereafter provided, pavement density measurements will be performed by the State on the compacted wearing surfaces using a nuclear density gauge. A control section of pavement approximately 150 m [500 feet] long will be designated at the start of the paving operations. Within the control section at least three randomly selected locations will be tested, to calibrate the nuclear density gauge.

After placement of pavement the Contractor shall cool the pavement to be tested by using ice and promptly cut the necessary calibration cores. After cooling to 20 °C [70 °F] the cores shall be removed from the road using an acceptable core removing tool to assure minimum damage to the core.

The nuclear density gauge will then be adjusted to reflect the average of the cores. The Engineer reserves the right to designate a new control section at any time.

Each days placement will be divided into test sections one paver width wide for density testing.

The minimum acceptable density for each test section shall be as follows:

- (a) Roadway (excluding shoulders) - 92.1 percent of theoretical maximum density (TMD).
- (b) Shoulders placed on gravel with design depth of 40 mm [1½ inches] or less - 90.1 percent of the TMD.
- (c) Shoulders not covered by (b) above - 92.1 percent of the TMD.

When nuclear testing is required at locations outside normal paving and traffic control areas, the Contractor shall furnish a flagger and other necessary safety devices to protect personnel and equipment.

If the nuclear density gauge is not available the Contractor will be required to cut cores using the following procedure:

On the first day of paving and immediately after the initial pavement has cooled enough to obtain an undisturbed sample, the Contractor shall cut sample cores from the compacted wearing surface for testing by the Engineer. Samples shall be taken for the full depth of the course. On the morning of the second and all subsequent working days the Contractor shall cut sample cores from the previous days placement and present them to the plant inspector prior to 10:00 A.M. All first and subsequent day sample locations will be as designated by the Engineer.

After compaction, the percentage of the TMD obtained shall be a minimum of 93 percent for all machine placed courses, except when plans call for shoulder paving on a gravel surface with a design depth of 40 mm [1½ inches] or less, the percentage of the TMD shall be a minimum of 91.0 percent. The test for TMD shall be performed in accordance with AASHTO T209 on laboratory specimens of mixture combined in the same proportions as the job mix formula.

All holes in the pavement resulting from cutting cores by the Engineer or by the Contractor shall be filled with acceptable mixture no later than the following work day. Before filling, the holes shall be carefully cleaned and coated with emulsified asphalt.

On projects where the total estimated quantity of bituminous binder and base course exceed 1000 Mg [1000 Tons], the Contractor shall cut two base or binder course samples on the first day of paving immediately after the initial pavement has cooled enough to obtain undisturbed samples for the full depth of the course for testing by the Engineer. Thereafter, one core sample shall be cut for every 5000 Mg [5000 Tons] of base and binder course placed on Interstate projects and one core sample for every 3000 Mg [3000 Tons] on non-interstate projects. The Contractor shall present the core samples to the plant inspector as soon as practical after cutting, but no later than 10:00 a.m. the morning after the mix is placed. All first day and subsequent day core sample

locations will be as designated by the Engineer. Bituminous base and binder shall be considered as one entity when implementing this requirement.

401.20 Surface Tolerances. The surface shall be tested by the Engineer with a 4.9 m [16 foot] straightedge or string line placed parallel to the centerline of pavement and with a 3 m [10 foot] straightedge or string line placed transversely to the centerline of pavement. Variations exceeding 6 mm [$\frac{1}{4}$ inch] shall be corrected by removing defective work and replacing with new material as directed. A 3 m [10 foot] straightedge, shall be furnished by the paving contractor.

401.21 Method of Measurement. Plant mix pavement will be measured by the megagram [ton] in accordance with Section 109 -- Measurement and Payment. Batch masses [weights] will not be permitted as a method of measurement, unless the alternate provisions of Section 401.082(e) are met in which case the cumulative mass [weight] of all the batches will be used for payment. The megagrams [tonnage] shall be the mass [weight] used in the accepted pavement and no deduction will be made for the mass [weight] of bituminous material or additives in the mixture.

Due to possible variation in the specific gravity of the aggregate and field changes in areas to be paved, the quantity of mixture used may vary from the estimated quantities and no adjustment in contract unit price will be made because of the variations.

401.22 Basis of Payment. All work performed and measured as prescribed above will be paid for as provided in respective sections for each type specified.

Work specified in Subsection 401.12 will be paid for at the contract unit prices for the material used except that cleaning objectionable material from the pavement and furnishing and applying bituminous material to joints and contact surfaces will be incidental.

SECTION 402 -- VACANT

SECTION 403 -- HOT BITUMINOUS PAVEMENT

403.01 Description. This work shall consist of constructing one or more courses of bituminous pavement on an approved base 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.

The bituminous pavement shall be composed of a mixture of aggregate, filler if required, and bituminous material.

MATERIALS

403.02 General. The materials and their use shall conform to the requirements of Subsections 401.02 through 401.06 and to the designated gradation requirements of Subsection 703.09.

CONSTRUCTION REQUIREMENTS

403.03 General. The construction requirements shall be as specified in Subsections 401.07 through 401.20.

In addition hot bituminous pavement placed on bridges shall also conform to the following requirements.

- (a) The mixture shall be placed in courses as specified in the Special Provisions.
- (b) The bottom course shall be placed with an approved rubber mounted bituminous paver of such type and operated in such a manner that the membrane waterproofing will not be damaged in any way.
- (c) The top course shall not be placed until the bottom course has cooled sufficiently to provide stability.
- (d) The Contractor will not be required to cut sample cores from the compacted pavement on the bridge deck.
- (e) After the top course has been placed, the shoulder areas shall be sealed 1 m [3 feet] wide with two applications of an emulsified bituminous sealer meeting the requirements of Subsection 702.12. The first application shall be pre-mixed with fine, sharp sand, similar to mortar sand, as needed to fill all voids in the mix in the

area being sealed. The second application may be applied without sand. The sealer shall be carried to the curb at the gutter line in sufficient quantity so as to leave a bead or fillet of material at the face of the curb. The area to be sealed shall be clean, dry and the surface shall be at ambient temperature.

(f) The furnishing and applying of the required quantity of sealer for the bridge shoulder areas shall be incidental to placing the hot bituminous pavement.

(g) The atmospheric temperature for all courses on bridge decks shall be 10 °C [50 °F] or higher.

403.04 Method of Measurement. Hot bituminous pavement will be measured as specified in Subsection 401.21.

403.05 Basis of Payment. The accepted quantities of hot bituminous pavement will be paid for at the contract unit price per megagram [ton] for the bituminous mixtures, including bituminous material complete in place.

Payment will be made under:

Pay Item	Pay Unit
403.07 Hot Bituminous Pavement, Grading B	megagram [ton]
403.08 Hot Bituminous Pavement, Grading C	megagram [ton]
403.09 Hot Bituminous Pavement, Grading C (Crushed Ledge)	megagram [ton]
403.10 Hot Bituminous Pavement, Grading D	megagram [ton]
403.101 Hot Bituminous Pavement, Grading D (Sidewalks, Drives, Islands and Incidentals)	megagram [ton]
403.11 Hot Bituminous Pavement, Grading D (Crushed Ledge)	megagram [ton]
403.12 Vacant	
403.121 Hot Bituminous Pavement, Grading E (Shimming)	megagram [ton]

SECTION 404 -- VACANT

SECTION 405 -- VACANT

SECTION 406 -- VACANT

SECTION 407 -- VACANT

SECTION 408 -- VACANT

SECTION 409 -- BITUMINOUS TACK COAT

MATERIALS

409.01 Description. This work consists of furnishing and applying one application of liquid bituminous material on an approved surface in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established.

409.02 Bituminous Material. The type and grade of bituminous material will be specified in the contract.

The bituminous material shall meet the applicable requirements of Section 702 -- Bituminous Materials. The bituminous material may be conditionally accepted at the source.

CONSTRUCTION REQUIREMENTS

409.04 Weather Limitation. Bituminous material shall not be applied on a wet surface, after sunset or before sunrise, or when the atmospheric temperature is below 10 °C [50 °F] in a shaded area at the job site, or when weather conditions are otherwise unfavorable to proper construction procedures.

409.05 Equipment. The Contractor shall provide necessary equipment to properly apply the bituminous material.

The distributor shall be designed, equipped, maintained and operated so that bituminous material at constant temperature may be applied uniformly on variable widths of surface up to 4.5 m [15 feet] at readily determined and controlled rates from 0.05 to 2.0 L/m² [0.01 to 0.5 gallons per square yard], with uniform pressure and with an allowable variation from any specified rate not to exceed 0.05 L/m² [0.01 gallon per square yard]. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump and full circulation spray bars adjustable laterally and vertically. Approved fog type nozzles will be required.

All liquid and cement bituminous material bulk delivery vehicles and distributors shall be equipped with an acceptable sampling valve.

On bulk delivery vehicles the valve shall be located in an accessible area in the lower half of the front or rear bulkhead. The valve shall be similarly located on distributors except that it may be installed in a circulating line having a rising flow.

409.06 Preparation of Surface. Prior to application of the bituminous tack coat the surface shall be thoroughly cleaned of all loose and objectionable material. Preparation of the surface shall be considered incidental to the contract.

409.07 Application of Bituminous Material. Bituminous material shall be applied by a pressure distributor in a uniform, continuous spread over the area to be treated and within the temperature range specified in Subsection 702.05. The rate of application and areas to be treated will be specified in the contract.

When traffic is maintained, one-way passage of vehicles will be maintained on the untreated portion of the roadway. Bituminous tack coat shall not be placed on any surface where traffic will be forced to travel upon the uncovered tack coat. All tack coat shall be covered on the day it is applied.

Care shall be taken so that the application of the bituminous tack coat at the junction of spreads is not in excess of the specified amount. Skipped areas and deficiencies shall be corrected as directed.

409.08 Method of Measurement. Unless otherwise specified, bituminous tack coat will be measured by the liter [gallon].

All quantity determinations will be made in accordance with Section 109 -- Measurement and Payment.

409.09 Basis of Payment. The accepted quantity of bituminous tack coat will be paid for at the contract unit price per liter [gallon] for the designated type of material complete in place.

Payment will be made under:

Pay Item	Pay Unit
409.15 Bituminous Tack Coat, Applied	liter [gallon]

SECTION 410 -- BITUMINOUS SURFACE TREATMENT

410.01 Description. This work consists of furnishing and applying one or more courses of bituminous treatment and aggregate cover material when required on an approved surface in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established.

- (a) Prime coat shall consist of an application of low viscosity liquid bituminous material to coat and blend mineral particles preparatory to placing a bituminous base or surface course. A light coat of cover material may be required.

- (b) Seal coat shall consist of an application of bituminous material and cover material. A double Seal coat shall consist of a second application of bituminous material and may require a second application of cover material.

MATERIALS

410.02 Bituminous Material. The types and grades of bituminous material will be specified in the contract. The grade may be changed one grade by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 702 -- Bituminous Materials. The bituminous material may be conditionally accepted at the source.

410.03 Aggregates. The type of cover coat material will be specified in the contract.

Cover material for prime coat shall meet the requirements of Subsection 703.13, Sand Cover or Subsection 703.14.

Cover material for Seal Coat shall meet the requirements of Subsection 703.13, Stone Chips or Sand Cover.

The cover material will be accepted in the stockpile at the source.

CONSTRUCTION REQUIREMENTS

410.04 Weather Limitations. Bituminous material shall not be applied on a wet surface, after sunset or before sunrise or when the atmospheric temperature is below 10 °C [50 °F] in the shade or when weather conditions are otherwise unfavorable to proper construction procedures.

410.05 Equipment. The equipment used by the Contractor shall include scarifying, mixing, spreading, finishing, compacting equipment, a bituminous distributor and equipment for heating bituminous material.

The aggregate spreader shall be a type that a uniform and accurately controlled amount of aggregate will be distributed regardless of the speed of the spreader or the towing vehicle.

The distributor shall be designed, equipped, maintained operated so that bituminous material at constant temperature be applied uniformly on variable widths of surface up to 4.5 m [15 feet] at readily determined and controlled rates from 0.2 to 9.0 L/m² [0.05 to 2.0 gallons per square yard], with uniform pressure and with an allowable variation from any specified rate not to exceed 0.09

L/m² [0.02 gallon per square yard]. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank and thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump and full circulation spray bars adjustable laterally and vertically.

All liquid and cement bituminous material bulk delivery vehicles and distributors shall be equipped with an acceptable sampling valve.

On bulk delivery vehicles the valve shall be located in an accessible area in the lower half of the front or rear bulkhead. The valve shall be similarly located on distributors, except that it may be installed in a circulating line having a rising flow.

Traveling or stationary mixing plants or other equipment of proven performance may be used by the Contractor in place of the specified equipment if approved.

Rollers shall be self-propelled steel wheel tandem or 3 wheel rollers weighing not less than 7.25 Mg [8 tons] each and pneumatic tire rollers having a total compacting width of not less than 1.52 m [60 inches] and the gross weight adjustable within the range of 3.5 to 6.5 kg/mm [200 to 350 pounds per inch] of compaction width. The operating weight shall be as directed. Tire pressure or contrast pressure may be specified for pneumatic tire rollers.

410.06 Preparation of Surface. The surface to be treated shall be smooth, stable, uniformly compacted, free of ruts, corrugations or other irregularities. Prior to placing tack coat or seal coat the surface shall be thoroughly cleaned of all loose and objectionable material.

Unless otherwise authorized, a 5 day curing period shall be required between successive applications of bituminous material and cover material when specified, for construction of a multiple course surface treatment.

The cover material shall be evenly distributed and all excess material removed prior to the second application of bituminous material for a double seal coat.

410.07 Application of Bituminous Material. Bituminous material shall be applied by a pressure distributor in a uniform, continuous spread over the section to be treated and within the temperature range specified in Subsection 702.05.

The width of treatment and quantity of bituminous materials to be used per square meter [square yard] shall be as directed.

When the item for payment for Bituminous Surface Treatments is by the square meter [square yard], the type, grade and approximate quantity of bituminous material per square meter [square yard] will be specified.

Junctions of spreads shall be carefully made. For seal coats the spray bars of the distributor shall be started on building paper. Skipped areas and deficiencies in distribution for all types of surface treatments shall be corrected.

When traffic is maintained, one way passage of vehicles will be permitted on the untreated portion of the roadbed. Following satisfactory penetration and covering of prime coat, traffic may be transferred to the treated portion of the roadway.

When the rolling operation is finished, traffic may be transferred to the newly completed seal coat. Protection from fast moving vehicles shall be furnished as provided for in the contract or as directed.

The length of spread of bituminous material shall not be in excess of that which trucks, loaded with aggregate can immediately cover. Under no circumstances shall bituminous material be allowed to chill or set up, dry or otherwise impair retention of the cover coat.

410.08 Application of Aggregate Cover. If after the application of the prime coat, the bituminous material fails to penetrate satisfactorily and the roadway must be used by traffic, the specified cover coat material shall be spread in the amounts required to absorb any excess bituminous material. The primed surface shall be maintained by subsequent spreading of additional cover material.

When the item for payment for Bituminous Surface Treatment is by the square meter [square yard], the type and approximate quantity of aggregate cover per square meter [square yard] for prime coat and seal coat will be specified.

Immediately following the application of the bituminous material, the specified cover material for seal coat shall be spread in quantities as designated. Cover material for seal coat shall be spread with a self-propelled aggregate spreader unless otherwise specified or directed. Spreading shall be in such a manner that the tires of the trucks or aggregate spreader at no time contact the uncovered and newly applied bituminous material.

When the aggregate cover material specified for seal coat is stone chips, the Engineer may require drag brooming before rolling. If deemed necessary, sand cover shall be uniformly distributed with a wire fabric drag.

Following completion of the rolling operation the seal coat shall be maintained by distributing aggregate cover over the surface to absorb any excess bituminous material and to cover any areas deficient in cover material. Light brooming may be required.

Maintenance shall continue until the treated surface has become stable. When directed all excess aggregate cover material shall be removed by rotary brooms.

410.09 Rolling. Initial rolling of cover material for seal coat shall begin immediately after brooming and shall consist of one complete coverage with a steel wheel roller. Rolling with a pneumatic roller shall follow the initial rolling. The amount of pneumatic tire rolling shall be sufficient to seal the aggregate cover material and shall not be less than 2 complete coverages. At all times rollers shall move at a speed slow enough to avoid loosening embedded aggregate cover.

410.10 Method of Measurement. Unless otherwise specified bituminous material will be measured by the liter [gallon], aggregate cover material and blotter material by the megagram [ton] or cubic meter [cubic yard], measured in the truck.

When specified in the contract as a pay item, Bituminous Surface Treatment will be measured by the square meter [square yard].

All quantity determinations will be made in accordance with Section 109 -- Measurement and Payment.

410.11 Basis of Payment. The accepted quantity of bituminous material will be paid for at the contract unit price per liter [gallon] for the designated type of material complete in place.

The accepted quantity of aggregate cover material will be paid for at the contract unit price per megagram [ton] or per cubic meter [cubic yard] in accordance with the contract pay item for the type of material complete in place.

The accepted quantity of bituminous surface treatment will be paid for at the contract unit price per square meter [square yard] complete in place which price shall include furnishing and applying bituminous materials, aggregates and additives when required.

Payment will be made under:

Pay Item	Pay Unit
410.12 Asphalt Cement, Applied	liter [gallon]
410.13 Tar, Applied	liter [gallon]
410.14 Cut-back Asphalt, Applied	liter [gallon]
410.15 Emulsified Asphalt, Applied	liter [gallon]
410.16 Cover Coat Material, Sand	cubic meter [cubic Yard]
410.17 Cover Coat Material, Stone Chips	cubic meter [cubic Yard]
410.18 Cover Coat Material, Stone Chips	megagram [ton]
410.19 Blotter Material	cubic meter [cubic Yard]
410.20 Bituminous Surface Treatment	square meter [square Yard]

SECTION 411 -- UNTREATED AGGREGATE SURFACE COURSE

411.01 Description. This work shall consist of constructing a surface course or levelling course of untreated aggregate on an approved base 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.

MATERIALS

411.02 Aggregate. Aggregates shall conform to the requirements of Subsection 703.10, Aggregate for Untreated Surface Course and Levelling Course.

CONSTRUCTION REQUIREMENTS

411.03 Placing. The surface course material shall be spread evenly in one layer upon the prepared base course to a depth that will insure the required depth after being compacted. The aggregate, when spread, shall be well graded with no pockets of fine or coarse material and shall be bladed and shaped with a power grader.

411.04 Compaction. Compacting shall be done with rollers, heavy construction equipment or any combination capable of satisfactorily compacting the course. The Contractor shall maintain the moisture content of the material to attain the required compaction.

When the aggregate surface material lacks sufficient fines to obtain compaction, binder material of an approved quality shall be added. The binder material shall be uniformly incorporated into the surface material by means of harrowing or by other methods capable of obtaining satisfactory results. The amount added shall not increase the total fines in the mixture to exceed the limits specified.

411.05 Surface Tolerance. The entire surface shall be shaped and maintained to a tolerance of 10 mm [3/8 inch] above or 10 mm [3/8 inch] below the required cross sectional shape.

411.06 Levelling Course. When Aggregate Levelling Course for fine grading aggregate base and subbase course is called for, it shall be placed, measured and paid for under the contract item for Untreated Aggregate Surface Course.

411.07 Method of Measurement. Untreated aggregate surface course will be measured by the cubic meter [cubic yard] in place unless designated by pay item to be measured by truck measure. When measured in place, the width and thickness for measurement will be the width and thickness of aggregate surface as shown on the plans or as modified. The length will be along the centerline. All measurements will be in accordance with Section 109 -- Measurement and Payment. When

designated by pay item to be measured by truck measure, the measurement will be in vehicles at the point of delivery as shown on delivery slips in accordance with Subsection 109.01(f).

Aggregate surface course, designated by pay item to be measured in place and used for driveways and other locations difficult to accurately measure in place, may be measured in vehicles at 80 percent of the number of cubic meters [cubic yards] accepted and used, at the point of delivery as shown by delivery slips in accordance with Subsection 109.01(f). The quantity so measured shall not exceed 300 m³ [300 cubic yards] per contract.

411.08 Basis of Payment. The accepted quantities of untreated aggregate surface course of the type specified will be paid for at the respective contract price per cubic meter [cubic yard]. Payment shall include purchasing material, stripping pits, excavating, crushing and screening when necessary, hauling, placing, compacting and other necessary processes which are required to furnish acceptable material under this item.

Water added or fines added or both added to the material to aid compaction and to prevent ravelling will be at the Contractor's expense.

Payment will be made under:

Pay Item	Pay Unit
411.09 Untreated Aggregate Surface Course	cubic meter [cubic Yard]
411.10 Untreated Aggregate Surface Course, Truck Measure	cubic meter [cubic Yard]

SECTION 412 -- BITUMINOUS MULCH SURFACE COURSE

Reserved

SECTION 413 -- COLORED SYNTHETIC BINDER PAVEMENT

Reserved

SECTION 414 -- PLANT MIXED SURFACE TREATMENT

Reserved

SECTION 415 -- PLANT MIXED WEARING COURSE

Reserved

SECTION 416 -- HOT BITUMINOUS TRENCH SURFACING

Reserved

SECTION 417 -- STABILIZED AGGREGATE SURFACE COURSE

Reserved

SECTION 418 -- HOT ROADWAY SURFACE COURSE

Reserved

SECTION 419 -- SAWING AND SEALING JOINTS IN BITUMINOUS PAVEMENT

Reserved

SECTION 420 -- PORTLAND CEMENT CONCRETE PAVEMENT

Reserved

SECTIONS 421 THROUGH 424 VACANT

SECTION 425 -- RECYCLED BITUMINOUS PAVEMENT

425.01 Description. This work shall consist of processing existing pavement with new aggregate and a bituminous binder material in an approved mixing plant and placing and compacting the mixture in reasonably close conformity with the lines, grades and dimensions shown on the plans or as established by the Engineer.

MATERIALS

425.02 Existing Pavement. That portion of the removed material required in the Hot Recycled Pavement shall be crushed in such a manner that 100 percent passes a 25 mm [1 inch] sieve unless otherwise directed by the Engineer.

425.03 New Aggregate. New aggregate for the recycled mixture shall be crushed rock, crushed or uncrushed gravel, sand or stone screening or a combination of two or more of these materials. New individual aggregates shall meet the quality requirements of Subsection 703.07(a) and 703.07(b). The composite blend of new aggregates, minus that portion represented by reclaimed asphalt pavement, shall meet the quality requirements of Subsection 703.07(c).

425.04 Bituminous Material. The bituminous binder material shall meet the applicable requirements of Section 702 -- Bituminous Material.

425.05 Composition of Recycled Mixtures. The recycled mixture shall consist of crushed old pavement, new aggregate and bituminous binder material. The composite blend of the recycled mixtures shall meet the following master gradation limits.

<u>Sieve Size</u>	<u>Percent by Weight Passing Square Mesh Sieves</u>
25 mm [1 inch]	100
19 mm [3/4 inch]	80-100
12.5 mm [1/2 inch]	50-85
4.75 mm [No. 4]	28-60
2.36 mm [No. 8]	20-50
1.18 mm [No.16]	14-39
300 m [No. 50]	6-24
150 m [No.100]	4-16
75 m [No.200]	1-8

The Contractor shall submit, for the Engineer's approval, a job mix formula for the recycled mixture to be supplied. The job mix formula shall establish a single percentage of old pavement and new aggregates so that the composite gradation is within the master gradation limits. The job mix formula shall state the name of the refiner and supplier of the particular bituminous material to be used.

At the time the job mix formula is submitted, the Contractor shall make available for sampling and testing, stockpiles of crushed old pavement and new aggregate proposed for use. A minimum of 10 days shall be allowed for testing by the Department, prior to approval of the job mix formula.

Upon approval of the mix, the Engineer will establish as a part of the job mix formula, a percentage of new bituminous binder material to obtain a minimum Hveem stability of 25 and will establish temperatures of the mixture at the two points of discharge.

After the job mix formula is established, the components and temperatures of the mixture shall conform within the following tolerances:

Aggregate portion of mix: Sieve Sizes	Tolerance (Percent)	
Passing 50 mm to 19 mm	[2 inch to 3/4 inch]	±10
Passing 12.5 mm to 4.75 mm	[1/2 inch to No. 4]	±7
Passing 2.36 mm	[No. 8]	±6
Passing 1.18 mm	[No. 16]	±5
Passing 600 m to 300 m	[No. 30 to No. 50]	±4
Passing 150 m	[No. 100]	±3
Passing 75 m	[No. 200]	±2

Bituminous Material:

Percent of Mixture	+0.4 -0.2

Temperature of Mix:

In the truck at the mixing plant	±10 °C [±20 °F]
At the Paver	±10 °C [±20 °F], but also to maximum plant temperature

CONSTRUCTION REQUIREMENTS

425.06 Weather Limitations. Unless otherwise specified, recycled bituminous pavement shall not be placed on a wet surface or when the air temperature is too cool to allow proper handling and finishing of the mixture. Recycled bituminous pavements shall be constructed only between the dates of April 15th and November 15th unless it is in the public interest for service to traffic in which case the Department may approve extending the dates of the paving season.

425.07 Bituminous Mixing Plant (Hot Recycled). The bituminous mixing plant shall be capable of heating and drying the crushed old pavement and the new aggregates. The plant shall be capable of delivering a uniformly mixed material containing an accurately measured amount of bitumen.

425.08 Mixing. The mixing of the recycled pavement shall conform with acceptable practices of the paving industry except screening of the aggregate into individual hot bins will not be required.

The hot recycled pavement shall be sufficiently dried so that the mixture will not flush, foam excessively, or displace excessively under the action of the rollers. The moisture content of the hot

recycled pavement, sampled behind the laydown machine prior to compaction shall not exceed 1.0 percent by weight.

After the required amount of crushed old pavement, new aggregate and bituminous binder material have been introduced into the mixer, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous binder material throughout the mixture is obtained.

The mixing plant shall be capable of independently controlling and proportioning the crushed old pavement, new aggregate, and bituminous binder material in conformance with the job mix formula.

During the initial production of the recycling mixture, the Contractor shall adjust the plant and change the designated percentage of crushed old pavement in the mix as necessary to arrive at a product that will meet the specified gradation and that can be produced at a reasonable and desirable rate.

425.09 Automatic Ticket Printer.

- (a) In place of plant and truck scales, the Contractor may provide an approved automatic printer system, which will print the weights of the material delivered.
- (b) The above system must be used in conjunction with an approved automatic batching and mixing control system.
- (c) Weights shall be printed on a weight ticket for each load.
- (d) In the event of a malfunction of the automatic printer system, production may be continued for a period not to exceed the next 48 hours, providing total weights for each batch are recorded on weigh tickets and certified by a Licensed Weighmaster.
- (e) Plant scales shall be inspected as often as the Engineer may deem necessary to assure their continued accuracy.
- (f) The Contractor shall have on hand not less than ten 25 kg masses* [ten 50 pound weights] for testing the scales.

*The Contractor may continue to use the present 22.68 kg masses [50 pound weights] as long as they remain serviceable. If new masses are needed, a set of ten 25 kg masses shall be supplied.

425.10 Hauling Equipment. Trucks used for hauling recycled bituminous mixtures shall have tight, clean, smooth, metal beds which have been thinly coated with a minimum amount of lime solution or an approved soap solution to prevent the mixture from adhering to the beds. Such

trucks shall have a cover of canvas or other suitable water resistant material of such size as to protect the mixtures from the weather.

425.11 Condition of Existing Surface. The surface upon which the recycled bituminous mixture is placed shall be thoroughly cleaned of all objectionable material.

When the surface of the existing base or pavement is irregular, the surface shall be brought to uniform grade and cross section as directed.

425.12 Bituminous Pavers. Recycled mixture produced under this contract shall be placed on the roadway and shoulders with a paver equipped with an automatic grade and slope controlled screed, unless otherwise directed by the Engineer.

425.13 Rollers. Rollers for hot recycled pavement shall be as specified in Subsection 401.11.

425.14 Preparation of Bituminous Binder Material. The bituminous material shall be prepared in such a manner that will avoid local overheating and provide a continuous supply of the material to the mixer at all times. The method of introducing the bituminous binder material to the mixture shall be selected by the Contractor and approved by the Engineer.

425.15 Spreading and Finishing. The mixture shall be placed upon an approved surface, spread and struck off to the grade and elevation established. Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial width as may be practicable.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be dumped, spread and screened by hand to give the required compacted thickness.

425.16 Compaction. Immediately after the bituminous mixture has been spread, struck-off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.

The surface shall be rolled when the mixture is in the proper condition and when rolling does not cause undue displacement, cracking or shoving.

When rolling, care shall be exercised not to displace the line and grade of the edges of the bituminous mixture. To prevent adhesion of the mixture to the rollers the wheels shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted.

Any mixture which becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh material which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of bituminous material shall be removed and replaced.

After compaction the minimum percentage of the theoretical maximum density (TMD) obtained shall be 93 percent for all recycled mixture placed by machine. The test for the theoretical

maximum density (TMD) shall be performed in accordance with AASHTO T209 on laboratory specimens of mixture combined in the proportions of the job mix formula.

425.17 Surface Tolerances. A 3 m [10 foot] straightedge, acceptable to the Engineer, shall be supplied by the Contractor, and shall at all times be available at the paving operation. The surface of the completed course will be tested by the Engineer using the 3 m [10 foot] straightedge at selected locations. The variance of the surface from the testing edge of the straightedge between any two contacts shall not exceed 6 mm [1/4 inch]. All humps or depressions exceeding the specified tolerance shall be corrected by removing defective work and replacing it with new material as directed.

425.18 Method of Measurement. Recycled bituminous pavement will be measured by the megagram [ton] in accordance with Section 109 -- Measurement and Payment. Batch weights will be permitted as a method of measurement if the provisions of Automatic Ticket printer are met in which case the cumulative weight of all batches will be used for payment. The weight used for pay purposes shall be the weight used in the accepted pavement, and no deduction will be made for the weight of bituminous binder material in the mixture.

Due to possible variation in the specific gravity of the aggregate and field changes in areas to be paved, the quantity of mixture used may vary from the estimated quantities and no adjustment in contract unit price will be made because of the variations.

425.19 Basis of Payment. The accepted quantities of recycled pavement will be paid for at the contract unit price per megagram [ton] for the recycled mixtures, including bituminous binder material, complete in place.

Payment will be made under:

Pay Item	Pay Unit
425.20 Hot Recycled Pavement	megagram [ton]

SECTIONS 426 THROUGH 429 VACANT

SECTION 430 -- COBBLESTONE PAVEMENT

Reserved

SECTION 431 -- BRICK PAVEMENT

Reserved

SECTIONS 432 THROUGH 459 VACANT

SECTION 460 -- HOT BITUMINOUS PAVEMENT FOR SPECIAL AREAS

460.01 Description. This work shall consist of one or more courses of bituminous mixture constructed on an approved foundation in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections established.

MATERIALS

460.02 Composition of Mixtures. The bituminous plant mix shall be composed of a mixture of aggregate and bituminous material. The several aggregate fractions shall be sized, uniformly graded and combined as follows:

Sieve	Percent Passing
25 mm [1 inch]	100
19 mm [3/4 inch]	90-100
12.5 mm [1/2 inch]	50-90
4.75 mm [No. 4]	28-60
2.36 mm [No. 8]	20-50
1.18 mm [No. 16]	14-39
300 µm [No. 50]	6-24
150 µm [No. 100]	4-16
75 µm [No. 200]	1-8

460.03 Aggregates-General. Aggregates in the stockpiles at the plant site shall meet the following requirements:

- (a) Coarse Aggregate, that material retained on the 2.36 mm [No. 8 sieve], shall be crushed stone or crushed gravel and shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft or disintegrated pieces and free from stone coated with dirt or other objectionable material.
- (b) Fine aggregate, that material passing the 2.36 mm [No. 8 sieve], shall consist of natural sand or sand prepared from stone or gravel or a combination thereof. It shall consist of hard, tough grains, free from injurious amounts of clay, loam or other deleterious substances.

460.04 Vacant

460.05 Bituminous Material. Bituminous material shall meet the requirements of Section 702 -- Bituminous Material, including the latest revisions for the type and grade chosen by the Contractor and approved. The bitumen content (percent of mix) shall be within the range of 4.5 to 6.5 percent.

CONSTRUCTION REQUIREMENTS

460.06 Weather Limitations. Unless otherwise specified, hot bituminous pavement for special areas shall not be placed on a wet surface nor when the air temperature is too cool to allow proper compaction. Plant-mixed bituminous pavements shall be constructed between the dates of May 1st and November 15th.

Weather conditions shall be satisfactory for the safety of the personnel, general public, and proper handling and finishing of the mixture.

When it is in the public interest for service to traffic, the Department may extend the dates of the paving season.

460.07 Bituminous Mixing Plant. The bituminous mixing plant shall be capable of heating and drying the aggregate. The plant shall be capable of delivering a uniformly mixed material containing an accurately measured amount of bitumen.

460.071 Vacant

460.072 Automatic Ticket Printer. In place of plant and truck scales, the Contractor shall an approved automatic printer system which will print the weights of the material delivered. The printer system must be used with an approved automatic batching and mixing control system showing weights on a weight ticket for each load.

In the event of a malfunction of the automatic printer system, production may be continued for a period not exceeding the next 48 hours providing total weights of each batch are recorded on weight tickets and certified by a Licensed Weighmaster. Plant scales shall be inspected as often as the Engineer may deem necessary to assure their continued accuracy. The Contractor shall have on hand not less than ten 25 kg masses* [ten 50 pound weights] for testing of the scales.

*The Contractor may continue to use the present 22.68 kg masses 50 pound weights as long as they remain serviceable. If new masses are needed, a set of ten 25 kg masses shall be supplied.

460.08 Hauling Equipment. Trucks used for hauling bituminous mixtures shall have tight, clean, smooth, metal beds which have been thinly coated with a minimum amount of lime solution or other approved material to prevent the mixture from adhering to the beds. During or after each

application, the truck bodies shall be raised to allow the excess to drain. The trucks shall have a cover of canvas or other suitable water repellent material of such size as to protect the mixture from the weather. When necessary, so that the mixture will be delivered on the road at the specified temperature, truck beds shall be insulated and covers shall be securely fastened.

460.09 Bituminous Pavers. Mixture produced under this contract shall be placed on the roadway with an approved self-propelled bituminous finishing machine designed for highway paving.

460.10 Vacant.

460.11 Conditioning the Existing Surface. The surface upon which bituminous mixture is to be placed shall be thoroughly cleaned of all objectionable material.

When the surface of the existing base or pavement is irregular, it shall be brought to uniform grade and cross section as directed.

460.12 Preparation of Bituminous Material. The bituminous material shall be heated in a manner that will avoid overheating, and provide a continuous supply of the bituminous material to the mixer at uniform temperature at all times.

The Contractor shall determine with the Engineer the amount of bituminous material used each day on a particular project.

460.13 Preparation of Aggregates. The aggregates for the mixture shall be dried and heated to the required temperature. Flames used for drying and heating shall be properly adjusted to avoid damage to the aggregate and to avoid soot on the aggregate.

460.14 Mixing. The processing of the aggregate, handling bitumen, drying the aggregate and mixing shall conform to acceptable practices of the paving industry, except screening of the aggregate into individual hot bins will not be required.

The aggregate shall be sufficiently dried so that the mixture will not flush, foam excessively, or displace excessively under the action of the rollers.

After the required amount of aggregate and bituminous material have been introduced into the mixer and unless otherwise specified, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is obtained.

460.15 Spreading and Finishing. The mixture shall be laid upon an approved surface, spread and struck off to the grade and elevation established. Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial widths as may be practicable.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be dumped, spread and screeded to give the required compacted thickness.

460.16 Compaction. Immediately after the bituminous mixture has been spread, struck-off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling with steel rollers.

The surface shall be rolled when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking or shoving.

When rolling, care shall be exercised not to displace the line and grade of the edges of the bituminous mixture. To prevent adhesion of the mixture to the rollers, the wheels shall be kept moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted.

Mixture that becomes loose and broken, mixed with dirt or is in any way becomes defective shall be removed and replaced with fresh, hot mixture which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of bituminous material shall be removed and replaced.

460.17 through 460.19 Vacant

460.20 Method of Measurement. Plant mix bituminous pavement will be measured by the megagram [ton] in accordance with Section 109 -- Measurement and Payment. Batch weights will be permitted as a method of measurement, if the provisions of Subsection 460.072 are met, in which case the cumulative weight of all the batches will be used for payment. The weight used for pay purposes shall be the weight used in the accepted pavement and no deduction will be made for the weight of bituminous material or additives in the mixture.

Due to possible variation in the specific gravity of the aggregate and field changes in areas to be paved, the quantity of mixture used may vary from the estimated quantities and no adjustment in contract unit price will be made because of the variations.

460.21 Basis of Payment. The price per megagram [ton] shall be considered full compensation for furnishing and hauling the mixture, placing, rolling, sweeping and all labor and equipment necessary to complete the work. All handwork required will be considered incidental.

Payment will be made under:

Pay Item	Pay Unit
460.22 Hot Bituminous Pavement	megagram [ton]

DIVISION 500 -- STRUCTURES

SECTION 501 -- FOUNDATION PILES

501.01 Description. This work shall consist of furnishing and driving piles and casings of the types and dimensions specified on the contract plans. Piles shall conform to and be installed as detailed in these specifications in reasonably close conformity to the lines, grades, and locations shown on the plans or as authorized by the Engineer. Work under this item shall also consist of any pile testing specified by the project contract plans and described in these specifications.

MATERIALS

501.02 Materials. Materials shall meet the requirements of the following subsections of Division 700 - Materials:

Steel Pipe Piles	711.01
H-Beam Pile Tips	711.09
Structural Steel	713.01

H-beam piles shall be structural steel and shall meet the requirements of AASHTO M183/183M (ASTM A36/A36M). Mill test reports will be required. Notch toughness tests will not be required.

Concrete for Steel Pipe Piles and Steel Casings shall be Class S and shall meet the requirements of Section 502 - Structural Concrete.

Steel casings shall conform to the material requirements of steel pipe piles.

Reinforcing steel for Steel Pipe Piles and Steel Casings when called for, shall meet the requirements of Section 503 - Reinforcing Steel.

CONSTRUCTION REQUIREMENTS

501.03 Equipment. Piles may be driven with steam, air, or diesel hammers. Gravity hammers, except as noted on the plans, shall only be used to drive timber piles. When gravity hammers are used to drive timber piles, the ram shall be between 900 and 1600 kg [2,000 and 3,500 pounds] and the height of drop shall not exceed 5 m [15 feet]. In no case shall the ram

weight be less than the combined weight of the drive head and pile. All gravity hammers shall be equipped with hammer guides to insure concentric impact on the drive head.

The plant and equipment furnished for steam and air hammers shall have sufficient capacity to maintain at the hammer, under working conditions, the volume and pressure specified by the manufacturer. The plant and equipment shall be equipped with accurate pressure gauges which are easily accessible to the Engineer. The weight of the striking parts of air and steam hammers shall not be less than $\frac{1}{3}$ the weight of drive head and pile being driven.

Open-end (single acting) diesel hammers shall be equipped with a device such as rings on the ram or a scale (jump stick) extending above the ram cylinder, to permit the Engineer to visually determine hammer stroke at all times during pile driving operations. Also, the Contractor shall provide the Engineer with a chart from the hammer manufacturer equating stroke and blows per minute for the open-end diesel hammer to be used. Closed-end (double acting) diesel hammers shall be equipped with a bounce chamber pressure gauge, in good working order, mounted near ground level so as to be easily read by the Engineer. Also, the Contractor shall provide the Engineer a chart, calibrated to actual hammer performance within 90 days of use, equating bounce chamber pressure to either equivalent energy or stroke for the closed-end diesel hammer to be used.

All pile driving equipment furnished by the Contractor shall be approved by the Engineer prior to use. All pile driving equipment shall be sized such that the specified piles can be driven to the required ultimate capacity, without damage, as indicated on the plans. Approval of the pile driving equipment by the Engineer will be based on the wave equation analysis unless The Alternate Approval Method, as described herein, is designated on the plans.

The Contractor shall submit to the Engineer the necessary pile driving equipment information at least 14 days prior to driving piles. The Engineer will respond in writing as to the adequacy of the Contractor's driving equipment proposal.

The Contractor will be notified of the acceptance or rejection of the driving system within 7 calendar days of the Engineer's receipt of the Pile and Driving Equipment Data Form. If the wave equation analyses show that the driving system is unacceptable, the Contractor shall modify or replace the proposed equipment, at his/her expense, until subsequent wave equation analyses indicate the piles can be driven to the desired ultimate capacity, without damage. The Engineer will notify the Contractor of the acceptance or rejection of the revised driving system within 7 calendar days of receipt of a revised Pile and Driving Equipment Data Form.

The criteria, which the Engineer will use to evaluate the driving equipment from the wave equation results, consists of both the required number of hammer blows/25 mm [blows per inch] at the required ultimate pile capacity and the pile stresses during driving. The required number of hammer blows indicated by the wave equation at the ultimate pile resistance shall be between 3 and 15 blows/25 mm [3 and 15 blows per inch] for the driving equipment to be acceptable.

In addition, for the driving equipment to be acceptable, the pile stresses indicated by the wave equation shall not exceed the values where pile damage impends. The point of impending damage in steel piles is defined as a compressive driving stress of 90 percent of the specified yield point of the pile material. For timber piles, the compressive driving stress shall not exceed the allowable working stress shown on the plans.

The Alternate Approval Method of driving will be used when specified on the plans. The Alternate Approval Method requires that the energy of the driving equipment submitted for approval on the Pile and Driving Equipment Data Form, be rated by the manufacturer at or above the appropriate minimum energy level in Table 1 corresponding to the ultimate pile capacity shown on the plans.

TABLE 1
ALTERNATE APPROVAL METHOD
Minimum Pile Hammer Requirements

<u>Ultimate Pile Capacity</u>		<u>Minimum Mfrs. Rated Hammer Energy</u>	
<u>(kN)</u>	<u>(Kips)</u>	<u>kNm</u>	<u>(Foot-lbs.)</u>
800 and under	(180 and under)	12.2	(9,000)
801 to 1334	(181 to 300)	20.3	(15,000)
1335 to 1868	(301 to 420)	27.1	(20,000)
1869 to 2400	(421 to 540)	32.5	(24,000)
2401 to 2669	(541 to 600)	35.3	(26,000)

During pile driving operations, the Contractor shall use the approved system. No variations in the driving system will be permitted without the Engineer's written approval. Any change in the driving system will be considered only after the Contractor has submitted a revised equipment data form. The Contractor will be notified of the acceptance or rejection of the driving system changes within 7 calendar days of the Engineer's receipt of the requested change. The time required for submission, review, and approval of a revised driving system shall not constitute the basis for a contract time extension to the Contractor.

Leads: Pile driver leads shall be constructed in such a manner as to afford freedom of movement of the hammer and to insure proper support of the pile during driving.

Followers: Followers shall only be used when approved in writing by the Engineer, or when specifically stated in the contract documents. In cases where a follower is permitted, the first pile in each group and every tenth pile driven thereafter shall be driven full length without a follower, to verify that adequate pile length is being attained to develop the desired pile capacity. The follower and pile shall be held and maintained in equal and proper alignment during driving. The follower shall be of such material and dimensions to permit the piles to be driven to the length determined necessary from the driving of the full length piles. The final position and alignment of

the first two piles installed with followers in each substructure unit shall be verified in accordance with location tolerances.

Hammer Cushion: All power pile driving equipment shall be equipped with a suitable thickness of hammer cushion material to prevent damage to the hammer and pile and to insure uniform driving behavior. Hammer cushions shall be made of durable, manufactured materials, provided in accordance with the hammer manufacturer's guidelines except that all wood, wire rope, and asbestos hammer cushions are specifically disallowed and shall not be used. A striker plate as recommended by the hammer manufacturer shall be placed on the hammer cushion to insure uniform compression of the cushion material. The hammer cushion shall be inspected in the presence of the Engineer when beginning pile driving at each pile group or after each 100 hours of pile driving, whichever is less. Any reduction of hammer cushion thickness exceeding 10 percent of the original thickness shall be replaced by the Contractor before driving is permitted to continue.

Pile Drive Head: Piles driven with power hammers require an adequate drive head to distribute the hammer blow to the pile head. The drive head shall be axially aligned with the hammer and the pile. The drive head shall be guided by the leads and not be free-swinging. The drive head shall fit around the pile head in such a manner as to prevent transfer of torsional forces during driving while maintaining proper alignment of hammer and pile.

For special types of piles, appropriate driving heads, mandrels, or other devices shall be provided in accordance with the manufacturer's recommendations so that the piles may be driven without damage.

501.04 Driving Procedures and Tolerances. The sequence of driving piles in any unit shall be subject to the approval of the Engineer. The ground surface shall be brought to the bottom of the footing elevation prior to driving the piles. The Contractor shall furnish all assistance required to make any observations and measurements.

When driving is interrupted before final penetration is reached, data for the bearing capacity of the pile shall not be taken until at least 300 mm [12 inches] of pile penetration or pile refusal has been attained, after driving has been resumed.

Jetting shall be done only with the permission of the Engineer. When water jets are used the number of jets and the volume and pressure of the water at the nozzles shall be sufficient to erode freely the material adjacent to the piles. The plant shall have sufficient capacity to deliver at all times at least 690 kPa [100 pounds per square inch] pressure at two 19 mm [3/4 inch] jet nozzles. Before the desired penetration is reached, the jets shall be withdrawn and the piles shall be driven with the hammer to secure the final penetration.

When a vibratory hammer is used, the Contractor will be required to demonstrate to the satisfaction of the Engineer, that the ultimate capacity, as called for on the plans, is attained and that an acceptable method of measuring the ultimate capacity of each pile is provided. The

demonstration may be accomplished by a pile loading test or by comparison driving, using a power hammer. Each pile driven by a vibratory hammer shall require proof testing by the use of a power hammer. No additional compensation will be made for demonstrations or proof testing.

Concrete shall not be placed in pipe piles until pile driving has progressed beyond a radius of 5 m [15 feet] from the pile to be concreted. If pile heave is detected for pipe piles which have been filled with concrete, the piles shall be redriven to the original position after the concrete has attained sufficient strength and a proper hammer-pile cushion system, is in place as is satisfactory to the Engineer.

Piles which have heaved more than 5 mm [0.25 inch] during the driving of other piles in a group shall be resealed to the required penetration or bearing capacity at the Contractor's expense.

The Contractor will be responsible to hold the piles in place to allowable tolerances. Piles shall be driven with a variation of not more than 20 mm/m [$\frac{1}{4}$ inch per foot] from the vertical or from the batter shown on the plans. The cutoff elevation of piles for trestle bents shall not be out of position by more than 50 mm [2 inches] from the dimensions shown on the plans. As approved by the Engineer, piles for trestle bents may be pulled into position as long as excessive stresses are not induced in the piles. The cutoff elevation of piles, other than for trestle bents, shall not be out of position by more than 150 mm [6 inches]. Actual embedment of the piles in the concrete shall be within 150 mm [6 inches] of that shown on the plans.

501.05 Special Requirements for Steel Pipe Piles and Steel Casings. Pipe piles shall be driven closed ended, unless otherwise specified. When open ended pipe piles are specified or when the ends are not completely closed ended when driven, the inside of the pile shall be thoroughly cleaned out, and the inside walls cleaned by jetting or other means approved by the Engineer.

Pipe piles shall be inspected and approved by the Engineer immediately before concrete is placed. They shall be free from rupture and undue deformation and shall be free from water unless the Engineer determines that the concrete can be placed without damage to the pile and such that the discharged water will be contained. The Contractor shall provide lights and other equipment necessary to inspect each pipe pile.

Portland cement concrete for filling the pipe piles shall be placed in one continuous operation to fill the pile completely without causing water contamination. An internal type vibrator shall be used in the top 8 m [25 feet]. Pile heads shall be protected and cured in accordance with Section 502 - Structural concrete.

The placing of concrete and the driving of piles shall be so scheduled that fresh and setting concrete will not be injured by the driving.

Steel casings shall be driven over H-beam piles through steel templates located inside the casings. A reinforcing steel cage, when specified, shall be placed inside the casings with a minimum of 50 mm [2 inches] coverage and the casings shall be filled with concrete to the elevation shown on the plans.

Full length steel casings shall be used wherever practicable; however, splicing may be permitted when approved by the Engineer. The method of splicing shall be as follows:

- (a) Steel casings shall be spliced by full penetration butt joint welds.
- (b) When the casings are to be spliced while in a vertical position the welds shall be single-bevel groove welds with the use of back-up rings. When the casings are to be spliced while in a horizontal position, the welds shall be single-vee groove welds with the use of back-up rings.
- (c) Welding shall comply with the requirements of Subsection 504.20 and 504.21 for shop welding and 504.48 and 504.49 for field welding.

501.06 Defective Piles and Corrective Measures. The procedure incident to the driving of piles shall not subject the piles to excessive and undue abuse causing deformation. Any pile damaged by reason of internal defects, by improper driving, or driven below cutoff elevation, shall be considered defective and shall be corrected by and at the expense of the Contractor.

501.07 Pile Testing and Acceptance. Pile testing will be required as shown on the plans.

Pile testing will be required to confirm that piles attain the required ultimate bearing capacity.

A static load test consists of the application of a known load to the pile or group of piles and the accurate measurement of the resulting settlement.

In the case of Steel Pipe Piles, no load shall be placed on the pile for at least 7 days after the concrete has been placed in the shell.

A static loading testing shall be conducted under the direction of the Engineer, but the Contractor shall furnish all labor and equipment.

A dynamic load test consists of mounting instruments on the pile and accurately recording the output during driving.

On completion of either static or dynamic load testing, any test or anchor piling, not a part of the finished structure, shall be removed or cut off at least 300 mm [1 foot] below either the bottom of the footing or the finished ground elevation, whichever is lower.

When Wave equation analysis is specified, the piles shall be driven to the required resistance as shown by the Wave equation blows/25 mm [blows per inch]. The pile acceptance will be based on the Wave Equation analysis and the results of any specified testing, unless otherwise designated on the plans. When the alternate approval method is specified on the plans, piles shall be driven to practical refusal of 10 blows/25 mm [10 blows per inch].

The wave equation analysis will not be considered valid under any of the following conditions.

1. The hammer or striking part does not have a free fall.
2. The head of the pile becomes broomed or crushed.
3. The penetration is not reasonably quick and uniform.
4. There is an appreciable bounce after a blow.
5. The hammer is operated outside the parameters recommended by the manufacturer.

When a static load test is specified in the contract documents, load tests shall be performed by procedures set forth in ASTM D1143 using the quick load test method except that the test shall be taken to plunging failure, four times design load, or 900 Mg [1,000 tons], whichever occurs first. Testing equipment and measuring systems shall conform to ASTM D1143. The Contractor shall submit to the Engineer for approval, detailed plans, prepared by a licensed professional engineer, of the proposed loading apparatus. The apparatus shall be constructed to allow the various increments of the load to be placed gradually without causing vibration to the test pile. When the approved method requires the use of tension (anchor) piles, such tension piles shall be of the same type and diameter as the production piles and shall be driven in the location of permanent piles when feasible, except that timber or tapered piles installed in permanent locations shall not be used as tension piles.

The plunging failure load of a pile tested under axial compressive load is that load which produces a settlement at failure of the pile head equal to:

METRIC UNITS

$$S_f = S + (3.81 + 0.008D)$$

Where:

S_f = Settlement at failure in millimeters

D = Pile diameter or width in millimeters

S = Elastic deformation of total unsupported pile length in millimeters.

For piles greater than 610 mm in diameter or width:

$$S_f = S + 0.85D$$

ENGLISH UNITS

$$S_f = S + (0.15 + 0.008D)$$

Where:

S_f = Settlement at failure in inches

D = Pile diameter or width in inches

S = Elastic deformation of total unsupported pile length in inches.

For piles greater than 24 inches in diameter or width:

$$S_f = S + D/30$$

The top elevation of the test pile shall be determined immediately after driving and again just before load testing to check for heave. Any pile which heaves more than 5 mm [1/4 inch] shall be redriven or jacked to the original elevation prior to testing. Unless otherwise specified in the contract, a minimum 3-day waiting period shall be observed between the driving of any anchor piles or the load test pile and the commencement of the load test.

When a dynamic load test is specified in the contract documents, dynamic measurements will be taken by the Contractor during the driving of piles designated by the Engineer as dynamic load test piles. Prior to placement of the pile in the leads, the Contractor shall make the designated pile available for obtaining wave speed measurements and for predrilling the required instrument attachment holes. Predriving wave speed measurements will not be required for steel piles. When wave speed measurements are made, the piling shall be in a horizontal position and not in contact with other piling. The Contractor will furnish the equipment, materials, and labor necessary for drilling holes in the piles for mounting the instruments. The instruments will be attached near the head of the pile with bolts placed through drilled holes on the steel piles or with wood screws for timber piles.

The Contractor shall furnish electric power for the dynamic test equipment. The power supply at the outlet shall be 10 amp, 115 volt, 55-60 cycle, A.C. only. Field generators used as the power source shall be equipped with functioning meters for monitoring voltage and frequency levels.

The Contractor shall drive the pile to the depth at which the dynamic test equipment indicates that the ultimate pile capacity, as called for on the plans, has been achieved, unless directed otherwise by the Engineer. The stresses in the piles will be monitored during driving with the dynamic test equipment to ensure that the values determined do not exceed the allowable values as determined by the Engineer. If necessary, the Contractor shall reduce the driving energy transmitted to the pile by using additional cushions or reducing the energy output of the hammer in order to maintain stresses at or below the allowable values. If non-axial driving is indicated by dynamic test equipment measurements, the Contractor shall immediately realign the driving system.

When directed by the Engineer the Contractor shall wait up to 24 hours and, after the instruments are reattached, retap the dynamic load test pile. A cold hammer shall not be used for

the redrive. The hammer shall be warmed up before redrive begins by applying at least 20 blows to another pile. The maximum amount of penetration required during redrive shall be 150 mm [6 inches] or the maximum total number of hammer blows required will be 50, whichever occurs first. After retapping, the Engineer will either provide the cutoff elevation or specify additional pile penetration and testing. The Contractor shall supply the Engineer with a report of the test results of each dynamically tested pile and a CAPWAP analysis within ten days of the completion of testing.

501.08 Test Piles. When required, test piles shall be driven as shown on the plans at the locations and to the lengths specified by the Engineer. This work shall be accomplished before pile driving is allowed to commence. All test piles shall be driven with power hammers unless specifically stated otherwise in the plans. In general, the specified length of test piles will be greater than the estimated length of production piles in order to provide for variation in soil conditions. The driving equipment used for driving test piles shall be identical to that which the Contractor proposed to use on the production piling. Driving equipment shall conform with the requirements of Section 501.03. The Contractor shall bring the ground at each test pile to the elevation of the bottom of the footing before the pile is driven.

Test piles shall be driven to the ultimate capacity, as determined with the wave equation by the Engineer, at the estimated tip elevation. Test piles which do not attain the hammer blow count specified above at a depth of 300 mm [1 foot] below the estimated tip elevation shown on the plans shall be allowed to "set up" 24 hours, before being redriven. A cold hammer shall not be used for redrive. The hammer shall be warmed up before driving begins by applying at least 20 blows to another pile. If the specified hammer blow count is not attained on redriving, the Engineer may direct the Contractor to drive a portion or all of the remaining test pile length and repeat the "set up" - redrive procedure. If the specified hammer blow count is not attained on redriving and the full length of the pile had been driven, the Contractor shall splice and drive additional pile as directed by the Engineer.

501.09 Splicing Piles. Full length piles shall be used wherever practicable. Piles shall not be spliced unless approved by the Engineer. Piles fabricated from multiple pieces will be acceptable only if they comply with the following:

Piles to 6 m [20 feet] long--no splices allowed
Piles over 6 m to 12 m [20 feet to 35 feet]--1 splice, maximum
Piles over 12 m to 20 m [35 feet to 70 feet]--2 splices, maximum
Piles over 20 m [70 feet]--3 splices, maximum

When splicing is authorized, piles shall be spliced as follows:

- (a) Damaged material shall be removed from the end of the driven pile. The ends of both sections to be spliced shall be cut off square with the longitudinal axis of the pile and scarfed as required. All cutting shall be done with the use of a mechanical guide and no free hand cutting will be allowed except for minor trimming.

- (b) A full penetration butt weld shall be used for the entire cross section of the pile.
- (c) All welding shall comply with the requirements of Section 504 -- Structural Steel, except as modified hereinafter.
 - 1. No run-off tabs will be required for flange butt welds on H-beam Piles.
 - 2. No welding shall be done when the temperature in the immediate vicinity of the weld is below -20 °C [0 °F]; when the surfaces are damp or exposed to rain, snow, or high wind; or when the welders or welding operators are exposed to inclement conditions.
 - 3. The pile shall be preheated to and maintained at 65 °C [150 °F] minimum within 150 mm [6 inches] from the weld while welding.
 - 4. The maximum electrode size shall be 4.76 mm [3/16 inch].
 - 5. Formal welding procedures need not be submitted.
- (d) Welders shall be prequalified in accordance with Section 504 - Structural Steel.
- (e) The Contractor may use other methods for splicing piles, if approved by the Engineer. Any alternate splices, so authorized, shall be capable of developing the full bending strength of the pile on both the x-x and y-y axis. If an H-pile splice incorporates a prefabricated pile splicer, the splicer shall be installed and welded as recommended by the manufacturer of the splices and shall be supplemented with a partial penetration groove weld on each flange with a 45° bevel on the upper member of the splice and a groove depth of approximately 75% of the nominal flange thickness (AWS D1.1, BTC-P4-GF). All welding shall conform to the requirements of (c) above.

501.10 Prefabricated Pile Tips. Steel H-beam piles shall be equipped with cast steel prefabricated pointed pile tips attached to the pile with a 8 mm [5/16 inch] groove weld or equivalent along each flange. Welding shall be done using low-hydrogen electrodes and the base metal shall be preheated to 65 °C [150 °F] minimum.

Unless otherwise shown on the plans, steel pipe piles shall have pointed cast steel pile tips, welded as above specified for H-beam pile tips.

Pile tips for both H-beam and pipe piles shall be approved by the Engineer.

Pile tips may be welded to the piles either by the supplier of the piles or in the field by the Contractor, at his option.

501.11 Method of Measurement.

- (a) Equipment Mobilization - a lump sum price bid for mobilization shall include the cost of furnishing all labor, materials, and equipment necessary for the transporting, erecting, dismantling, and removing the entire pile driving equipment.
- (b) Piles Furnished. The unit of measurement for furnishing casings, timber, and steel shall be the meter [linear foot]. The quantity to be paid for will be the sum of the lengths in meters [feet] of the piles, of the types and lengths ordered in writing by the Engineer. No allowance will be made for the length of piles, including test piles furnished by the Contractor, to replace piles which were previously accepted by the Engineer, but are subsequently damaged prior to completion of the contract. When extensions of piles are necessary, the extension length ordered in writing by the Engineer will be included in the length of piling furnished. All piles must be cutoff at the cutoff elevation shown on the plans. If the piles are cutoff at a higher elevation, the portion between these elevations will be deducted from this Item.
- (c) Piles in Place. Preboring, jetting or other methods used for facilitating pile driving procedures will not be measured and payment shall be considered included in the unit price bid for the Piles Driven pay item.

The quantity of H-beam, cast-in-place pipe or shell concrete piles to be paid for will be the actual number of meters [linear feet] of steel pipe or shell piles driven, cast, and left in place in the completed and accepted work. Measurements will be made from the tip of the steel pipe, shell pile, or H-beam pile to the cutoff elevation as shown on the plans. Unused pile cutoffs become the property of the Contractor.

No separate measurement will be made for reinforcing steel, excavation, drilling, cleaning of drilled holes, drilling fluids, sealing materials, concrete, required casing, and other items required to complete the work.

- (d) Pile Tips - Pile Tips will be measured by the number of tips authorized and satisfactorily installed.
- (e) Pile Splices - Pile splices will be measured by the number of splices authorized and satisfactorily completed to drive the piles in excess of the ordered length furnished by the Engineer.
- (f) Loading tests - Load tests will be measured by the number of unit tests authorized and satisfactorily made.

501.12 Basis of Payment. The accepted quantities of piles and casings will be paid for at the contract unit price per meter [linear foot], delivered, and complete in place. Such payment will include full compensation for any necessary excavation or backfilling required after driving, to bring the foundation area to the correct elevation.

Pile cutoffs and concrete for pipe piles and casings will not be paid for separately but will be considered as incidental to the related Pay Items.

Excavating and cleaning steel pipe piles and steel casings, furnishing and placing reinforcing steel and steel templates in steel pipe piles and steel casings will not be paid for separately, but will be considered as incidental to the related Pay Items.

Pile load tests, pile tips, and pile splices will be paid for at the contract unit price each.

Payment will be made under:

Pay Items as Furnished and in Place-Metric Units
Pay Unit

501.230 Static Loading Test

Each

501.231 Dynamic Loading Test

Each

501.36 Steel H-beam Piles 53 kg/m, delivered
meter

501.361 Steel H-beam Piles 53 kg/m, in place
meter

501.38 Steel H-beam Piles 62 kg/m, delivered
meter

501.381 Steel H-beam Piles 62 kg/m, in place
meter

501.40 Steel H-beam Piles 79 kg/m, delivered
meter

501.401 Steel H-beam Piles 79 kg/m, in place
meter

501.42 Steel H-beam Piles 85 kg/m, delivered
meter

501.421 Steel H-beam Piles 85 kg/m, in place
meter

501.44 Steel H-beam Piles 93 kg/m, delivered
meter

501.441 Steel H-beam Piles 93 kg/m, in place
meter

501.46 Steel H-beam Piles 109 kg/m, delivered
meter
 501.461 Steel H-beam Piles 109 kg/m, in place
meter
 501.48 Steel H-beam Piles 110 kg/m, delivered
meter
 501.481 Steel H-beam Piles 110 kg/m, in place
meter
 501.50 Steel H-beam Piles 132 kg/m, delivered
meter
 501.501 Steel H-beam Piles 132 kg/m, in place
meter
 501.52 Steel H-beam Piles 152 kg/m, delivered
meter
 501.521 Steel H-beam Piles 152 kg/m, in place
meter
 501.54 Steel H-beam Piles 174 kg/m, delivered
meter
 501.541 Steel H-beam Piles 174 kg/m, in place
meter
 501.70 Steel Pipe Piles, delivered
meter
 501.701 Steel Pipe Piles, in place
meter
 501.72 Steel Casings, delivered
meter
 501.721 Steel Casings, in place
meter
 501.90 Pile Tips
Each
 501.91 Pile Splices
Each
 501.92 Pile Driving Equipment Mobilization
Lump Sum

Pay Items as Furnished and in Place-English Units
Pay Unit

501.230 Static Loading Test
Each
 501.231 Dynamic Loading Test
Each
 501.36 Steel H-beam Piles 36 lbs/ft, delivered
Linear Foot

501.361 Steel H-beam Piles 36 lbs/ft, in place
 Linear Foot
 501.38 Steel H-beam Piles 42 lbs/ft, delivered
 Linear Foot
 501.381 Steel H-beam Piles 42 lbs/ft, in place
 Linear Foot
 501.40 Steel H-beam Piles 53 lbs/ft, delivered
 Linear Foot
 501.401 Steel H-beam Piles 53 lbs/ft, in place
 Linear Foot
 501.42 Steel H-beam Piles 57 lbs/ft, delivered
 Linear Foot
 501.421 Steel H-beam Piles 57 lbs/ft, in place
 Linear Foot
 501.44 Steel H-beam Piles 63 lbs/ft, delivered
 Linear Foot
 501.441 Steel H-beam Piles 63 lbs/ft, in place
 Linear Foot
 501.46 Steel H-beam Piles 73 lbs/ft, delivered
 Linear Foot
 501.461 Steel H-beam Piles 73 lbs/ft, in place
 Linear Foot
 501.48 Steel H-beam Piles 74 lbs/ft, delivered
 Linear Foot
 501.481 Steel H-beam Piles 74 lbs/ft, in place
 Linear Foot
 501.50 Steel H-beam Piles 89 lbs/ft, delivered
 Linear Foot
 501.501 Steel H-beam Piles 89 lbs/ft, in place
 Linear Foot
 501.52 Steel H-beam Piles 102 lbs/ft, delivered
 Linear Foot
 501.521 Steel H-beam Piles 102 lbs/ft, in place
 Linear Foot
 501.54 Steel H-beam Piles 117 lbs/ft, delivered
 Linear Foot
 501.541 Steel H-beam Piles 117 lbs/ft, in place
 Linear Foot
 501.70 Steel Pipe Piles, delivered
 Linear Foot
 501.701 Steel Pipe Piles, in place
 Linear Foot
 501.72 Steel Casings, delivered
 Linear Foot

- 501.721 Steel Casings, in place
Linear Foot
- 501.90 Pile Tips
Each
- 501.91 Pile Splices
Each
- 501.92 Pile Driving Equipment Mobilization
Lump Sum

SECTION 502 -- STRUCTURAL CONCRETE

502.01 Description. This work shall consist of furnishing and placing portland cement concrete for structures and incidental construction in accordance with these specifications and in reasonably close conformity with the lines, grades and dimensions shown on the plans or established.

502.02 Classification. The portland cement concrete shall be the class indicated on the plans.

MATERIALS

502.03 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Portland Cement and Portland Pozzolan Cement	701.01
Water	701.02
Air Entraining Admixtures	701.03
Water Reducing Admixtures	701.04
Water Reducing, High Range Admixture	701.0401
Set Retarding Admixtures	701.05
Curing Materials	701.06
Waterstops	701.07
Heavy Roofing Felt	701.08
Fly Ash	701.10
Calcium Nitrite Solution	701.11
Silica Fume	701.12
Fine Aggregate for Concrete	703.01
Coarse Aggregate for Concrete	703.02
Preformed Expansion Joint Filler	705.01
Bridge Drains	711.04

502.04 Shipping and Storage. Cement may be shipped in bags or in bulk from pretested and approved silos at the cement mill. The cement shall be completely protected from rain and moisture and any cement damaged by moisture or which fails to meet any of the specified requirements shall be rejected and removed from the site. If requested by the Engineer, cement stored for a period longer than 60 days shall be retested before being used in the work.

Bags of cement in shipment or storage shall not be piled more than 8 bags high. Bags of cement which for any reason have become partially set or which contain lumps of caked cement shall be rejected. Shipments of cement in bags shall be separately stored in a manner as to provide easy access for identification and inspection of each shipment.

Fly ash shall be stored at its source of supply in weathertight silos approved by the Engineer. All silos shall be completely empty and clean before fly ash is deposited therein unless the silo already contains fly ash of the same type.

Fly ash remaining in bulk storage at the source or distribution terminal for a period greater than one year after completion of tests will be resampled and retested by the Department before shipment or use.

Handling, shipping and stockpiling of aggregates shall be done in such a way as to minimize segregation and breakage.

Fine aggregate and each size of coarse aggregate shall be stored in definitely separated stockpiles on prepared bases constructed of the same material as is to be stockpiled with a minimum thickness of 300 mm [1 foot]. The ground under the prepared bases shall be reasonably graded to drain away from the stockpile and shall be free of brush or other harmful vegetation. The base shall be left in place, undisturbed for the duration of the use of the stockpile. Prepared bases can be salvaged for reuse provided this material is reprocessed. Barge floors, wood, metal or other hard surfaces shall be considered acceptable alternates for the prepared bases described above.

502.041 Testing Equipment. The Contractor shall provide test equipment and materials as specified below. The equipment and facilities shall be available and acceptable to the Engineer one week prior to placing any concrete. All such expense shall be considered incidental to the work and no additional payment will be made.

The Engineer will maintain the test equipment in reasonable condition. However, the Contractor shall replace any equipment that becomes unusable due to normal wear and tear or which is stolen or damaged from other than the Engineer's neglect or mistreatment. All such replacement costs shall be considered incidental to the work and no additional payment will be made.

The Contractor shall provide the following test equipment at the work site for use by Maine Department of Transportation personnel.

- (a) Slump test set (AASHTO T119)
- (b) Pressure Air Meter meeting requirements of AASHTO T152 (Type B) and all accessory items required for use with the particular design of apparatus. This shall include one 225 mm [9 inch] mason trowel, one metal scoop 225 mm long x 125 mm wide [9 inches long x 5 inches wide], one tamping rod conforming to AASHTO T119, one rubber mallet as described in AASHTO T152, one strike off bar (flat straight bar of steel).

The air meter shall be functional and shall bear a current calibration certificate issued by a recognized testing laboratory. Current shall mean within the calendar year.

- (c) Two pocket dial thermometers -20 to +95 °C [0 to 200 °F], 25 mm [1 inch] diameter dial, 125 mm [5 inch] pointed stem, unbreakable polycarbonate crystal, stainless steel case, stem and bezel. Accuracy required is 1 percent over entire range.
- (d) Air indicator kit (Chace method).
- (e) Steel "Contractors" rubber tired wheelbarrow.
- (f) Two D-handle square end shovels 240 mm [9½ inches] wide.
- (g) Two pair rubber gloves - heavy duty long cuff gloves.
- (h) Miscellaneous equipment - 500 mL plastic bottle, 19 L [5 gallon] bucket, scrub brush, 2 m [6 foot] folding rule and paper towels.

CONSTRUCTION REQUIREMENTS

502.05 Composition and Proportioning. Concrete shall be composed of a homogeneous mixture of portland cement or portland-pozzolan cement, fine aggregate, coarse aggregate, water and admixtures proportioned according to these specifications. All material shall be approved prior to use.

The Contractor may substitute fly ash for portland cement in accordance with the specifications. No fly ash shall be substituted when a portland-pozzolan cement is used. No additional payment will be made for any additional work required for the acceptance of the final product.

The Department reserves the right to discontinue the use of the fly ash at any time the desired product is not furnished. No additional compensation will be allowed for loss of work or profit. The remaining work shall be performed using the standard class of concrete as specified without the addition of fly ash.

METRIC UNITS

MASTER LIMITS TABLE

CLASS OF CONC. (f'c)	MINIMUM COMPRESSIVE STRENGTH MPa	MIN. CEMENT FACTOR kg/m³	MAX. WATER CEMENT mm (See 703.02)	MAX. SLUMP PERCENT	AIR CONTENT SIZE	MAX. COARSE AGGREGATE mm		
A	30	360	0.42	175	5 to 7½	25	4	
AA	30	380	0.40	175	5½ to 8½	19	4	
AASF	35	380	0.40	175	5½ to 8½	19	2,3,4	
B	20	310	0.49	100	4½ to 6½	25	1	
S	20	380	0.49	150	5 to 7	37.5	1	
P	See plans		430	0.40	175	5 to 7½	19	4,5

ENGLISH UNITS

MASTER LIMITS TABLE

CLASS OF CONC.	MINIMUM COMPRESS. STRENGTH (DESIGN f_c)	MIN. CEMENT FACTOR RATIO	MAX. CEMENT	MAX. WATER CEMENT	AIR SLUMP	MAXIMUM CONTENT	COARSE AGGRE.
	PSI	BAGS LBS/CY	INS.	PERCENT	INCHES		
A	4000	6.5	611	0.42	7	5 to 7½	1.0
AA	4000	6.75	635	0.40	7	5½ to 8½	0.75
AASF	5000	6.75	635	0.40	7	5½ to 8½	0.75
B	3000	5.5	517	0.49	4	4½ to 6½	1.0
S	3000	6.75	635	0.49	6	5 to 7	1.5
P	See plans	7.75	728	0.40	7	5 to 7½	0.75

NOTE #1 All concrete shall contain either a normal water reducing admixture (Type A) or a high range, water reducing admixture (HRWR) meeting the requirements of Section 701.0401. When a HRWR is used a maximum of 175 mm [7 inch] slump is allowed.

#2 Coarse aggregate shall be composed of ledge rock.

#3 All concrete shall contain a silica fume admixture meeting the requirements of Section 701.12.

#4 All concrete shall contain a high range, water reducing admixture meeting the requirements of Section 701.0401.

#5 Calcium Nitrite shall be added at the rate of 14.85 L/m³ [3 gallons per cubic yard].

Water-Cement Ratio (W/O) is by weight. One liter of water shall be considered to have a mass of 1 kg [One gallon of water shall be considered to weigh 8.34 pounds]. One bag of cement shall be considered to have a mass of 42.6 kg [94 pounds].

With the approval of the Engineer, Class AA may be substituted for Class A, and Class A or Class AA may be substituted for Class B.

Concrete to be placed by pumping equipment shall have a slump that does not exceed the specified master limit by more than 50 mm [2 inches] when deposited into the hopper of the pumping apparatus. Concrete slump at the point of discharge shall not exceed the limits specified in the Master Limits Table.

When silica fume additive is used in the concrete the rate of gross water to cement plus silica fume shall not exceed 0.40. Silica fume solids shall be used as an admixture at the rate of 25 kg/m³ [40 pounds per cubic yard]. A high range water reducing admixture shall be used.

When a high range water reducing admixture is added, a normal water reducing admixture (Type A) may be used. A set retarding admixture (Type D) may be used when the concrete temperature is over 20 °C [70 °F].

When a high range water reducing admixture is used, the minimum dosage shall not be less than the amount needed under AASHTO M194 to reduce the mixing water requirement by 12 per cent or more. The dosage used in the mix will be approved by the Engineer prior to placement.

A high range water reducing admixture shall be added after all other mix ingredients have been batched, except for the air entraining admixture, and the small additional mix water needed to achieve the desired slump. The maximum water cement ratio (W/O) shall not be exceeded.

A maximum replacement of fly ash for cement in the portland cement concrete mix shall be 15 percent by weight. Weights of fly ash used may be greater than the weight of portland cement replaced, but shall not be less than the weight of the portland cement replaced.

All concrete shall be air-entrained by the addition of an air-entraining admixture.

Concrete that has an air-content exceeding the specified tolerances may be used only with the approval of the Engineer.

The air-content of plastic concrete includes entrapped and entrained air. An entrapped air void is 1 mm or more in size and an entrained air void is less than 1 mm.

The Engineer may determine the percentage of entrained air in the hardened concrete. The testing procedure shall be in accordance with ASTM C457, Microscopical Determination of Air-void Content and Parameters of the Air-void System in Hardened Concrete. The specification will have been met if the entrained air in the hardened concrete is between 3.0 and 7.5 percent.

A set-retarding admixture shall be used in the concrete mix when called for on the plans, in the specifications, or when authorized or directed by the Engineer.

The following procedure will be used for approval of concrete mix ingredients and proportions. The mix ingredients furnished by the Contractor will be tested by the Department and must meet all specification requirements before concrete mix proportions are designated by the Engineer. In addition, the concrete mix design, without fly ash, shall be in accordance with either of the following subparagraphs, under (a) or (b).

(a) Concrete mix design proportions will be designated by the Engineer or

- (b) As an alternative, the Contractor shall have the option to submit his own concrete mix design proportions to the Engineer for approval. The approval will be contingent upon the ability of the mix design proportions to produce concrete which meets the specified water-cement ratio, strength requirement, and other factors which affect durability.

The mix design shall be based upon obtaining an average concrete strength sufficiently above the specified minimum compressive strength so that, considering the expected variability of the concrete and test procedures, no more than one in ten strength tests will be expected to fall below the specified minimum compressive strength. Mix designs shall be modified during the course of the work when necessary to ensure compliance with strength and consistency requirements.

Satisfactory performance of the proposed mix design shall be verified by laboratory tests on trial batches. The results of such tests shall be furnished to the Engineer by the Contractor at the time the proposed mix design is submitted. For mix design approval, the strengths of a minimum of five test cylinders taken from a trial batch shall average at least 5500 kPa [800 psi.] greater than the specified minimum compressive strength.

If materials and a mix design identical to those proposed for use have been used on other work within the previous year, certified copies of concrete test results from this work which indicate full compliance with these specifications may be substituted for such laboratory tests. If the results of more than 10 such strength tests are available from historical records for the past year, average strength for these tests shall be at least 1.28 standard deviations above the specified minimum compressive strength.

- (c) The minimum cement content specified in the Master Limits Table may be increased due to several factors including aggregate sources, concrete mix temperatures, low compressive strength test results and travel time.

When fly ash is used, concrete mix design proportions shall be the responsibility of the Contractor who shall submit certified design mix test data consisting of materials meeting the established requirements for the Department. The exact mix ingredients and proportioning used in the aforementioned design mix testing shall be the same as proposed to be used on the project. The proportions of mix ingredients shall be determined on an absolute volume basis.

A higher than minimum cement content will not allow the Contractor to exceed the time limits.

A mix design submitted by the Contractor shall include the following information:

- (a) Description of individual coarse aggregate stockpiles, original source, bulk specific gravity, absorption and gradation. A combined coarse aggregate blended gradation shall be provided.
- (b) Description of fine aggregate, original source, bulk specific gravity, absorption, colorimetric, gradation and Fineness Modulus (F.M.).
- (c) Description and amount of cement and fly ash.
- (d) Target water-cement ratio.
- (e) Target water content by volume.
- (f) Target strength.
- (g) Target air-content, slump and concrete temperature.
- (h) Target concrete unit weight.
- (i) Type and quantity (dosages of air-entraining and chemical admixtures).

The Contractor shall also submit for evaluation certified freeze-thaw testing results of a concrete mix with either identical or very similar mix ingredients and mix proportions as that proposed. The freeze-thaw testing shall conform to AASHTO T161 (ASTM C666), Procedure A, using 3.0 percent NaCl solution instead of plain water and the weight loss shall not be greater than 3.0 percent in 250 cycles. The approval will be contingent upon the ability of the mix design proportions to produce concrete which meets the specified water-cement ratio, strength requirement and other factors which affect durability. In determining the water-cement ratio, pozzolans are included as cementitious material. The weight of the cement, plus 100 percent of the weight of fly ash, shall be combined as the total weight of cementitious materials. For Type IP(MS) cement, this weight will be determined by multiplying the percent by weight of pozzolanic material in the cement times the total weight of cement per cubic meter [cubic yard].

All concrete mixes must be designed in accordance with the criteria of this subsection. The portion of the fine aggregates designated as a percent of the total aggregate shall provide a practical water-cement ratio not exceeding the maximum in the Master Limits Table. The design proportions must be stated in terms of aggregates in a saturated, surface-dry condition and the batch weights will be adjusted by the Engineer to account for the actual moisture of the aggregate at the time of use. If the quality and gradation of the aggregates proposed for the mix does not permit the design criteria to be achieved, then, instead of changing aggregates, additional cement, not to exceed a total cement content of 110 percent of the specified minimum for a mix without fly ash, 115 percent for a mix with fly ash, water reducing chemical admixtures or a combination for additional cement and water reducing chemical admixtures may be designated by the Engineer.

The Engineer may require 45 days from the date of availability of mix ingredients for sampling to allow testing of these ingredients and designating the design proportions or checking the design proportions as submitted by the Contractor.

No change in the source or character of the mix ingredients may be made without notice to the Engineer and no new mix ingredients shall be used until the Engineer has approved such ingredients and new mix proportions, if they change.

Process Control testing of air content, slump, water-cement ratio, and concrete mix temperature shall be performed by the Contractor on every load of portland cement concrete containing fly ash delivered to the job site. The Engineer will designate the portion or portions of the concrete batches that are to be sampled. The Contractor in the presence of the Engineer, shall cast and test for Process Control compressive strength a set of two 7 day and a set of three 28 day standard size cylinders for each cumulative total of 50 m³ [50 cubic yards] of portland cement concrete containing fly ash used on the project. The following AASHTO test procedures shall be used by the Contractor:

Sampling Fresh Concrete T141

Air Content of Freshly Mixed Concrete by the Pressure Method T152

Slump of Portland Cement Concrete T119

Making and Curing Concrete Compressive Testing
Specimens in the Field T231

Capping Cylindrical Concrete Specimens T231

Compressive Strength of Cylindrical Concrete Specimens T22

The testing machine used for compressive strength tests shall be subject to approval by the Engineer. Calibration of the machine shall be made in accordance with AASHTO T67 if deemed necessary by the Engineer.

502.051 Acceptability of Concrete Strength. A strength test will consist of the average strength of two compressive strength test cylinders fabricated from material taken from a single randomly selected batch of concrete, except that, if any cylinder should show evidence of improper sampling, molding, or testing, said cylinder will be discarded and the strength test will consist of the strength of the remaining cylinder.

For determining acceptability of concrete, test cylinders will be cured under controlled conditions as described in Article 9.3 of AASHTO T23 and tested at the age of 28 days. Samples

for acceptance tests for each class of concrete will be taken not less than once for each 150 m³ [150 cubic yards] of concrete or once for each major placement.

Any concrete represented by a test which indicates a strength which is less than the specified minimum compressive strength by more than 3500 kPa [500 psi] will be rejected and shall be removed and replaced with acceptable concrete. Such rejection shall prevail unless either:

- (1) The Contractor, at his or her expense, obtains and submits evidence of a type acceptable to the Engineer that the strength and quality of the rejected concrete is acceptable. If such evidence consists of cores taken from the work, the cores shall be obtained and tested in accordance with the standard methods of AASHTO T24 (ASTM C42) or,
- (2) The Engineer determines that said concrete is located where it will not create an intolerable detrimental effect on the structure and the Contractor agrees to a reduced payment to compensate the Department for loss of durability and other lost benefits.

Whenever the average of three consecutive tests, which were made to determine acceptability of concrete, falls to less than 1000 kPa [150 psi] above the specified minimum compressive strength or any single test falls more than 1400 kPa [200 psi] below the specified minimum compressive strength, the Contractor shall, at his or her expense, make corrective changes in the materials, mix proportions or in the concrete manufacturing procedures before placing additional concrete of that class. Such changes shall be approved by the Engineer prior to use.

502.06 Batching. Measuring and batching of materials shall be performed at an approved batching plant, either commercial or otherwise.

In batching aggregate for contracts having an estimated quantity of less than 20 m³ [25 cubic yards] of concrete, the Contractor may use approved volumetric measuring devices for both fine and coarse aggregate.

In batching aggregates for contracts having an estimated quantity of 20 m³ [25 cubic yards] of concrete or over but less than 75 m³ [100 cubic yards], the fine aggregate shall be weighed. When permitted by the Engineer, the Contractor may use approved volumetric measuring devices for the coarse aggregate. The volume of coarse aggregate to be used in each batch shall be determined by weighing a sample batch and using the volume, so determined, in each batch of concrete produced.

In batching aggregates for contracts having an estimated quantity of 75 m³ [100 cubic yards] of concrete or over, all aggregates shall be weighed.

The weighing and batching equipment shall be of such design and construction that the materials for each batch can be quickly and accurately weighed.

- (a) Portland Cement and Fly Ash, if used, or Portland- Pozzolan Cement. Either bagged or bulk cement may be used. No fraction of a bag of cement shall be used in a batch of concrete unless the cement is measured. All bulk cement shall be weighed on an approved weighing device. Accuracy of batching shall be plus or minus 1 percent of the required weight of portland cement, fly ash, if used, or portland-pozzolan cement.

When fly ash is weighed cumulatively with the cement, fly ash shall be last in the weighing sequence and the batching delivery tolerance for each material draw weight shall be based upon the total weight of cement plus fly ash.

- (b) Water. Water shall be measured by an approved device either by volume or by weight. The accuracy of the device for measuring the water under all operating conditions shall be within a range of error of not over 2 percent of the total mixing water. Measuring tanks 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 amount of water in the tank. The water measuring device at the batching plant shall be so arranged that the flow of water will be automatically stopped when the required quantity has been delivered to the mixer drum. All water measuring systems shall be capable of discharging the total quantity of measured water into the mixer drum within a limit of not greater than 1/3 of the specified mixing time or 1/3 of the specified minimum revolutions.

The water measuring device shall be so arranged that the measurements will not be affected by varied water pressure.

All wash water shall be removed from truck mixers and truck agitators prior to charging with a fresh load.

- (c) Aggregates. Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to secure a uniform grading of the material. Aggregates that have become segregated or mixed with earth or foreign material, shall not be used. All aggregates produced or handled by hydraulic methods and all washed aggregates, shall be stockpiled or binned for a sufficient length of time, as determined by the Engineer, to attain proper draining 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 high or non-uniform moisture content, storage or stockpile periods in excess of 12 hours may be required by the Engineer.

Batching of aggregates shall be so conducted as to result in the weights of materials being accurate within plus or minus 2 percent of the required weights.

- (d) Admixtures. Admixtures shall be added to the batch by means of an approved mechanical dispenser or other approved method capable of accurate measurement within a limit of accuracy of 3 percent. Admixtures shall be dispensed in such a manner as will insure uniform distribution of the material throughout the batch within the specified mixing period.

When 2 or more admixtures are added in the same concrete mix they shall not be allowed to mix prior to charging the mixer and shall be added separately.

The Engineer will designate the sequence and quantity of admixture to be added to each batch.

- (e) Bins and Scales. The batching plant shall include separate bins or compartments for fine aggregates and each size of coarse aggregate. One or more weighing hoppers and scales shall be provided for aggregates.

If cement is used in bulk, a separate bin, hopper and scale for cement only shall be included. The bulk cement weighing hopper shall be properly sealed and vented to preclude dusting during operations, it shall be self-cleaning and it shall be fitted with an attached vibrator to insure complete discharge. The discharge chute shall be so arranged that cement will not lodge in it nor leak from it.

For total project concrete quantities less than 400 m³ [500 cubic yards], the cement weigh hopper compartment need not be entirely separate from the aggregate weigh hopper compartment(s) as long as the cement and aggregate are each weighed and discharged separately before the other is introduced. In this case, one scale is allowed to weigh both cement and aggregate. The accuracy of this scale shall be plus or minus 1 percent of the required weight of cement.

Bins shall have adequate separate compartments for fine aggregate and each size of coarse aggregate and shall be amply partitioned to prevent spilling of separated aggregates into adjacent compartments.

Each aggregate and bulk cement, if used, and fly ash, if used, shall be discharged efficiently and freely into the appropriate weighing hopper. Means of control shall be provided so that as the quantity desired in the weighing hopper is being approached, the material may be added slowly and shut off with precision. A port or other opening for removing an overload and for sampling materials from the hopper shall be provided. Weighing hoppers shall be so constructed that: (1) there will be no attachments that might effect the free movement of the weighing mechanism; (2) they shall discharge fully; and (3) there shall be no possibility for

accumulation of materials on the inside or outside. The cement shall be kept separate from the aggregate until the batch ingredients are released for discharge.

The scales for weighing aggregates and cement and fly ash, if used, shall be of either the beam type or the springless-dial type and shall be accurate when static load tested to 0.5 percent of the total capacity of the scale. All exposed fulcrums, clevises and similar working parts of the scales shall be kept clean.

Poises shall be designed to be locked in any position to prevent any unauthorized change of position. When beam type scales are used, provisions shall be made for indicating to the operator that the required load in the weighing hopper is being approached. The device shall indicate within the last 100 kg [200 lb..] of load and within 25 kg [50 lb..] overload. All weighing and indicating devices shall be in full view of the operator while charging the hopper and he/she shall have convenient access to all controls.

The scales shall be tested and sealed at least once each year or as often as the Engineer may deem necessary to assure their continued accuracy. The Contractor shall have readily available not less than ten, 25 kg* [fifty-pound] weights for scale testing purposes when required by the Engineer.

*The Contractor may continue to use the present 22.68 kg masses [50 pound weights] as long as they remain serviceable. If new masses are needed, a set of ten 25 kg masses shall be supplied.

Batching plants may be equipped to proportion aggregates and bulk cement, and fly ash, if used, by automatic weighing devices of an approved type.

- (f) Transportation. When batches are hauled to the mixer, bulk cement shall be transported either in waterproof compartments or, if approved by the Engineer, between layers of fine and coarse aggregates. When cement is placed in contact with the aggregates, batches may be rejected unless mixing is begun within 30 minutes of such contact. Bagged cement may be transported on top of the aggregates.

Batches shall be delivered to the mixer separate and intact. Each batch shall be dumped cleanly into the mixer, without loss and when more than one batch is carried on the truck without spilling of material from one batch compartment into another.

The Contractor shall keep the batching equipment clean and in good adjustment and working order, including the scales and bins. The equipment shall be accurately operated when used for proportioning batches.

All batches which do not contain the proper amount of material shall be rejected.

If, for any reason, equipment previously approved becomes unsatisfactory, it shall be repaired or replaced before proceeding with the work.

The Engineer shall have the authority to require all batch trucks used for transporting unmixed batches from the batching plant to the mixer to be properly covered; that gates between the compartments shall fit properly to prevent leakage of material from one compartment to another; and that the size of the compartments be adequate to handle the volume of material being hauled.

502.07 Mixing and Delivery.

(a) Mixers and Agitators.

1. Mixers may be stationary or truck mixers. Agitators may be truck mixers or truck agitators. Each mixer and agitator shall have attached thereto, in a prominent place by the manufacturer, a metal plate or plates on which is plainly marked the various uses for which the equipment is designed, the capacity of the drum or container in terms of the volume of mixed concrete and the speed of rotation of the mixing drum or blades. These plates shall be kept in readable condition at all times.
2. Stationary mixers shall be equipped with approved water measuring devices as specified in Subsection 502.06 and timing devices that will not permit a batch to be discharged until the specified mixing time has elapsed. The timing device shall be equipped with a bell or other suitable warning devices that will give a clearly audible signal each time the lock is released. In case of failure of the timing device, the Contractor will be permitted to operate while it is being repaired, provided he furnishes an approved timepiece equipped with minute and second indicators. If the timing device is not in good working order within 24 hours, further use of the mixer will be prohibited until repairs are made.
3. All mixers and agitators shall be examined, as frequently as considered necessary, for changes in the condition of the drum, due to accumulation of hard concrete or mortar and for wear of blades.

(b) Loading.

1. No mixer or agitator shall be loaded in excess of the manufacturer's rated mixing or agitating capacity. No material for a batch of concrete shall be placed in the drum of a stationary mixer until all of the previous batch has been discharged.

2. For stationary mixers, batches shall be so charged into the mixer drum that some water will enter in advance of the cement and aggregate and all the water shall be in the drum by the end of the first one quarter of the specified mixing time.
3. Since workability losses, i.e., slump losses, for concrete mixes with high range, water reducing admixture increase for accompanying increases in temperature, the Engineer may require limitations on the maximum concrete truck loads.
4. The Engineer may require further reduction of the maximum loads of concrete mixes with high range, water reducing admixture if weather conditions or the amount of time to unload are also contributing to the premature stiffening of the mix.

(c) Mixing.

1. For stationary mixers, the total mixing time shall be not less than the following: 60 seconds for mixers of less than 1.5 m³ [2 cubic yards] capacity; 75 seconds for mixers of 1.5 to 3 m³ [2 to 4 cubic yards] capacity; and 90 seconds for mixers of more than 3 m³ [4 cubic yards] capacity. Mixing time shall be measured from the time all aggregates and cement are in the drum, water is being added as required in paragraph (b) of this Subsection and the drum or blades are rotating at the manufacturer's recommended mixing speed. This speed shall be maintained throughout the mixing period. Mixing time ends when the discharge chute opens. If such mixing does not result in a uniform and smooth texture, mixing shall be continued at the same rate of speed until satisfactory results are obtained.
2. For transit truck mixers, mixing shall be accomplished by obtaining a minimum of 60 revolutions of the drum or blades at the manufacturers designated mixing speed. Mixing shall be considered as started only after all of the mix ingredients, including enough water to achieve a minimum slump of 25 mm [1 inch] below the specified slump, are in the mixer drum. All mixing revolutions will be performed at the project site except some mixing revolutions may be allowed at the batch plant in the presence of the inspector. Before any concrete load is discharged at the project site, additional water may be added up to the maximum amount permitted under Subsection 502.05, to adjust the concrete mix to the required slump. Should it be necessary to hold the concrete in the mixer after mixing has been completed, the drum or blades shall be rotated at the manufacturer's designated agitating speed.
3. Concrete mixes containing a high range water reducing admixture added at the plant shall receive a minimum of 60 mixing revolutions at the plant and in the

presence of the plant inspector. A minimum of 100 revolutions will be necessary before the concrete is accepted.

4. Retempering concrete by adding water or by other means will not be permitted after a concrete load has been accepted at the project site as specified in Item 2.

If the consistency (slump) of a superplasticized concrete becomes unacceptable to either the Contractor or the Engineer, the mix may be replasticized once by the Contractor up to the amount of the original dosage of the high range, water reducer if approved by the admixture manufacturer. However, the discharge times allowed by standard specifications shall not be exceeded.

The range of slump of a superplasticized concrete mix for any placement shall be controlled within approximately 50 mm [2 inches] to ensure that the specified air content will be obtained.

5. When a high range water reducing admixture is to be added to the concrete at the job site and both the ambient and concrete temperatures are under 20 °C [70 °F], the Engineer may approve mixing to be started up to 45 minutes after the cement has been added. In all other cases, mixing of concrete shall begin within 30 minutes of the time that the cement has been added to the aggregate.

(d) Discharging.

1. Concrete, when discharged from mixers or agitators, shall be of the consistency and workability required for the job and shall be in accordance with Subsection 502.05.
2. The rate of discharge from a truck mixer shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate, if any, fully opened.

(e) Delivery.

1. Delivery and discharge from the mixer shall be completed within a maximum of 1½ hours from the time the cement is added to the aggregate, except that in hot weather when the concrete mix temperature exceeds 20 °C [70 °F] or under other conditions contributing to quick stiffening of the concrete, delivery and discharge from the mixer shall be completed within 1 hour. When approved by the Engineer, the use of a retarding admixture (Type D) may be used for increasing the 1 hour discharge time limit to 1½ hours, provided concrete

temperatures are kept below 27 °C [80 °F] and conditions contributing to quick stiffening of the concrete are not present.

2. When a truck agitator or truck mixer is used for transporting concrete that has been mixed, it shall be operated at the speed designated by the manufacturer as agitating speed so long as the concrete is in the drum.
3. When approved, concrete which has been designed for the purpose may be transported in suitable non-agitating equipment. The bodies or non-agitating equipment shall be of metal, smooth with rounded corners, watertight and equipped with gates which will control the discharge of the concrete. Approved covers shall be provided for protection against the weather.

Concrete transported in non-agitating equipment shall be delivered to the site of the work in a thoroughly mixed and uniform mass. Slump tests of representative samples taken during the discharge shall not differ by more than 50 mm [2 inches]. Discharge shall be completed within 45 minutes after introduction of the mixing water to the cement and aggregate.

4. Concrete which has been condemned for any reason shall be removed immediately from the job site and disposed of.
 5. Concrete mix temperature prior to placement shall not exceed 30 °C [85 °F].
- (f) Certification of Batches. The Department will provide a delivery ticket system when readymixed concrete is used.

The ticket will be issued to the truck operator at the batching plant for each truck load. The tickets shall be delivered to the Engineer or his inspector at the time and place of delivery. Loads for which tickets are not provided shall not be used in the work.

502.08 Cold Weather Concrete. Concrete shall not be placed against frozen surfaces.

All frost, ice, and snow shall be removed from all material which will be in contact with fresh concrete and all material that fresh concrete is to be placed upon.

Unless authorized by the Engineer, the mixing and placing of concrete shall be discontinued when the atmospheric temperature is below 5 °C [40 °F] in the shade and dropping and shall not be resumed until the atmospheric temperature is as high as 2 °C [35 °F] in the shade and rising. If authorization is granted for the mixing and placing of concrete under atmospheric conditions different from those specified above, the water shall be heated to a temperature not exceeding 82 °C [180 °F]. When either the aggregate or water is heated to above 50 °C [120 °F], they are to be combined first in the mixer before the cement is added. If the atmospheric temperature is below -

4 °C [25 °F], the aggregate shall also be heated when directed by the Engineer. Materials containing frost or lumps of frozen material shall not be used. Stockpiled aggregates may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over a fire. When aggregates are heated in bins, steam coil or water coil heating or other methods which will not be detrimental to the aggregates may be used. The heating apparatus shall be capable of heating the mass uniformly and preventing the occurrence of spots of overheated material. The temperature

of the mixed concrete shall be between the minimum values shown in the following chart and 20 °C [70 °F] when it is placed in the forms. Salt or other chemicals shall not be added to the concrete for any reason whatsoever, except by written permission of the Engineer.

MINIMUM FORM DIMENSION SIZE IN MILLIMETERS			
Less than 300 mm	300-900 mm	900-1800 mm	Greater than 1800 mm
13 °C	10 °C	7 °C	5 °C
MINIMUM CONCRETE TEMPERATURE AS PLACED			

COLD WEATHER TEMPERATURE TABLE
ENGLISH UNITS

MINIMUM FORM DIMENSION SIZE IN INCHES			
less than 12"	12"-36"	36"-72"	greater than 72"
55 °F	50 °F	45 °F	40 °F
MINIMUM CONCRETE TEMPERATURE AS PLACED			

When concrete is placed under the above cold weather conditions or when concrete has been in place less than the minimum curing period specified under Subsection 502.15 and the ambient temperature drops below 2 °C [35 °F], the Contractor shall furnish sufficient canvas and housing framework or other type of covering, to enclose and protect the structure. Sufficient insulation or heating apparatus and fuel to furnish all required heat, shall be supplied. When dry heat or approved insulation is used, means of preventing loss of moisture from the concrete shall be provided. The temperature of the concrete and its surfaces shall be kept above 10 °C [50 °F] for the first 4 days of the curing period and above 0 °C [32 °F] for the remainder of the minimum curing period specified under specification 502.15 and in the 24 hours following the curing period the temperature of the concrete shall be gradually decreased but not to exceed a total of 28

°C [50 °F] for thin deck and similar sections; 22 °C [40 °F] for moderate sections such as abutments and pier bents; and 17 °C [30 °F] for mass sections such as massive piers.

When permitted by the Engineer, footings may be protected by completely submerging them by admitting water inside the cofferdam. Until submersion takes place the temperature of the concrete and its surface shall be controlled as specified above. Submersion shall proceed slowly and the temperature of the air or water shall be maintained sufficient to prevent ice from forming within the cofferdam for a period of 7 days after the placing of the concrete.

When depositing concrete under water, there shall be no ice inside the cofferdam.

Permission given to place concrete under the conditions mentioned above shall not relieve the Contractor of responsibility for obtaining satisfactory results. The Contractor shall be wholly responsible for the protection of concrete during cold weather operations and any concrete injured by frost action or overheating shall be removed and replaced at the Contractor's expense.

502.09 Consistency. The required consistencies for the various classes of concrete shall meet the requirements of Subsection 502.05. The consistency shall be measured in millimeters [inches] of slump of the mixed concrete.

Consistency tests shall be made, at the discretion of the Engineer, at intervals during the placing of concrete, for the purpose of controlling the uniformity of the mix.

The slump of mixed concrete shall be determined in accordance with the requirements of AASHTO T119.

502.10 Forms and Falsework.

- (a) Construction of Forms. All forms shall be well built, substantial and unyielding, securely braced, strutted and tied to prevent motion and distortion while concrete is being placed in them and strong enough to support safely, in addition to the weight of the concrete, all superimposed loads (such as runways, concrete buggy loads, workmen, scaffolding, etc.) placed upon them.

All lumber used for exposed surface forms shall be made of sized and dressed tongue and groove lumber with a minimum thickness of 20 mm [25/32 inch]; or lumber that is dressed on one or both sides and both edges to a uniform thickness after dressing of not less than 32 mm [1¼ inches] or plywood of an exterior plyform grade, 5-ply, bonded with a waterproof glue and having a minimum thickness of 16 mm [5/8 inch]. Other form material may be used with permission of the Engineer.

Undressed lumber of uniform thickness, otherwise fulfilling the requirements for lumber dressed on one side, may be used for surfaces that will not be exposed in the finished structure.

Lumber for studding, walings, struts and braces shall be free from winds, cracks and other structural defects rendering it unsatisfactory for the purpose for which it is to be used.

Forms shall be built to conform to the dimensions, location, contours and details shown on the plans. The faces of forms against which the concrete is to be placed shall be dressed smooth and uniform and shall be free from winds, twists, buckles and other irregularities.

Stay-in-place forms of any type will not be permitted for any part of the slab structures, unless otherwise indicated on the construction plans.

The placing of concrete in excavated pits and trenches without forms will be permitted only in exceptional cases and then at the discretion of the Engineer.

Except in the construction of forms for columns and round ended piers, the form lumber shall be placed horizontally.

All corners within the forms shall be fitted with chamfer strips mitred at their intersections, except that chamfer strips will not be required as follows: (1) on corners of slab blocking of interior steel beams and the inside of exterior steel beams; (2) on corners constructed transversely at the underside of the slab of superstructures which consist of a concrete slab on steel beams; (3) on footings not exposed to view; and (4) on all structures when more than 600 mm [2 feet] below the final finished ground line.

Chamfer strips shall have a width across the diagonal face between 15 and 20 mm [$\frac{1}{2}$ and $\frac{3}{4}$ inch]. The size to be adopted for a given portion of the work shall depend upon the general dimensions. Except where special size chamfer strips are shown on the plans, the size of chamfer strips shall be uniform on individual projects. Provision shall be made for the chamfering of the top edges of abutment bridge seats and wing walls, tops of piers and retaining walls, tops of through girders, roadway curbs, etc., by nailing chamfer strips inside the forms. Unless otherwise provided, all chamfer strips shall produce plain flat surfaces on the concrete.

The forms for beams, girders and spandrel arches shall be so constructed as to permit the sides to be removed without disturbing the supports.

All sawdust, chips, blocks, shavings and other foreign matter within the forms shall be removed before depositing concrete in them. To ensure and to facilitate thorough cleaning of forms, clean out ports shall be provided in the forms at all horizontal construction joints of abutments, piers, retaining walls and columns; and narrow forms may be built with removable sections.

All forms shall be held rigidly to correct alignment and location by ample supports, waling and braces. In all cases where metal anchorages or ties within or through the face forms are required to hold the forms in their correct position, such anchorages or ties shall be of ample strength and shall be so constructed that the metal work can be removed to a depth of not less than 25 mm [1 inch] from the face and back surfaces of the concrete without damaging such surfaces.

Elevations will be taken on the top flanges of structural steel beams and girders for the purpose of determining the depth of blocking necessary for the construction of the forms for the concrete slab, after the following conditions have been satisfied:

1. The satisfactory erection of the superstructure structural steel beams or girders, including any required flooring beams and stringers.
2. No foreign loads supported by the beams or girders.

The Contractor shall submit working drawings for approval of the proposed forms and falsework supporting the overhanging portion of the superstructure slab in accordance with Subsection 105.02. The working drawings shall show the size and location of the supporting members, the proposed loads and the weight of concrete forms to be carried by the members.

In the construction of forms and falsework for the portion of superstructure slabs overhanging the exterior members of steel beam and girder spans, forms and supporting devices resulting in point loadings on the webs of the exterior stringers shall not be used. Loads resulting from such supporting devices shall be distributed over sufficient area of the stringer webs to eliminate deflection of the webs and the resulting settlement of the forms. Such loads may be transferred directly to the stringer flanges by means of brackets or braces.

All forms shall be inspected and approved before the placing of any concrete within them.

- (b) Surface Treatment of Forms. In order to insure the non-adhesion of the mortar to the forms, the inside surfaces shall be uniformly coated with raw paraffin or other non-staining mineral oil, soaped or thoroughly wetted with water (except in freezing weather). If soap is used, it shall be mixed with sufficient water to produce a thin jelly-like substance. When forms are used more than once they

shall be thoroughly cleaned before each setting and recoated with oil, soap or other approved surface treatment.

When materials for surface treatment other than plain water are to be used, the application shall be done before the placing of the reinforcing steel.

Whenever forms are constructed several days in advance of filling with concrete, they shall be kept moist or otherwise protected against warping and other defects caused by the drying out of the lumber.

In order to protect the concrete from the damaging effect of pitch in knots, all knots in the exposed surfaces of forms shall be thoroughly shellacked before treating forms as described above.

- (c) Construction of Falsework. All falsework used for supporting reinforced concrete superstructures shall be composed of members having ample structural sections to resist, without appreciable deformation or settlement, the loads imposed upon them. In addition to the weight of the super structure, these loads shall include all forms, bracing, runways and other loads that may be imposed during construction. The weight of the superstructure shall be taken as the weight of all concrete to be placed before the removal of falsework. Falsework shall be well built, rigid and unyielding, securely braced, strutted and tied to prevent distortion and movement tending to produce vibration and deformation of the superstructure forms.

When the vertical members of falsework consist of piles or when framed or other falsework is supported upon piles, the piles shall be driven to secure a safe load resistance.

When falsework is supported upon mud sills, the sills shall consist of at least two layers of timbers, the upper layer being laid transversely to the one beneath. The foundation pressures resulting from the imposed loads upon mud sills (falsework, forms, fresh concrete, scaffolding, etc.) shall, in general, not exceed the following:

1. For firm sand, gravel, rotten rock, very firm clay and other similar soils in confined thick beds, 200 kPa [2 tons per square foot].
2. For loose sand and gravel and ordinary clay soils in confined thick beds, 100 kPa [1 ton per square foot].
3. For soft clay and firm alluvial soils, 50 kPa [1/2 ton per square foot].

All arch centering and falsework systems shall be designed to support all vertical loading and any differential settlement forces, all horizontal and longitudinal forces, and shall account for any temporary unbalanced loading due to the

placement sequence of the concrete. Sufficient redundancy shall be designed into centering or falsework systems so that the failure of any member shall not cause the collapse of the entire system. Design computations, layout drawings, and details of materials for the centering or falsework systems shall be submitted to the Engineer for approval. The erection of centering or falsework systems shall be accomplished in strict conformance with the approved design and details and shall use only the materials approved for use. No concrete shall be placed without prior approval of the Engineer. The approval of the Engineer of all or part of the centering or falsework system shall not be construed as in any way relieving the Contractor of his/her responsibility and the work shall be done entirely at the Contractor's risk.

Falsework or centering systems adjacent to and/or over traveled ways shall additionally be designed to resist any vibration forces due to traffic and shall incorporate sufficient protection against impact by errant vehicles.

Centering or falsework systems for structures adjacent to and/or over traveled ways shall be designed by a registered Professional Engineer, and any plans, computations, and working drawings shall be signed by that engineer. Prior to concrete placement the engineer responsible for the design of the centering or falsework system shall certify that the system was erected in conformance with the approved plans and design details.

Falsework shall be so constructed that the forms will have a camber, the amount depending upon the length of span, load and conditions of falsework framing.

Forms supported upon falsework shall be provided with a satisfactory means for their adjustment in the event of settlement or deformation of the falsework due to overloading or other causes.

Provisions shall be made by means of suitable wedges, sand boxes or other devices for the gradual lowering of falsework and rendering the supported structure self-supporting.

(d) Removal of Forms and Falsework.

1. Location, weather conditions, materials used and the character of the structure involved shall be considered in determining the time for the removal of forms. In general, forms shall not be removed until the concrete has set sufficiently to give forth a distinct "stony ring" when struck with a small hammer. In general, depending upon conditions, forms for vertical surfaces as well as supporting forms and falsework for slabs having a clear span of less than 3 m [10 feet shall not be removed for at least 7 days. Under similar conditions, supporting forms and falsework for

slabs and beams having a clear span of 3 m [10 feet] or more shall not be removed for a period of 14 to 21 days.

At the Contractor's option, the vertical forms of footings, walls, columns and sides of beams and slabs may be removed 48 hours after placement of concrete, exclusive of the time the ambient air temperature is below 7 °C [45 °F] and provided the following conditions are met:

Immediately after the forms are removed, defects in the concrete surface shall be repaired in accordance with Subsection 502.13 and the repaired area thoroughly dampened with water. The surfaces of exposed concrete shall be cured for the remainder of the 7 days by the application of an approved liquid membrane-forming compound applied in accordance with Subsection 502.15. Other methods of curing concrete may be used with the prior approval of the Engineer.

2. In cold weather, the Engineer may require that the length of time that forms and falsework are to remain in place, be increased.
 3. Forms and falsework shall not be removed without the consent of the Engineer. The Engineer's consent shall not relieve the Contractor of responsibility for the safety of the work. Blocks and bracing shall be removed at the time the forms are removed and in no case shall any portion of the wood forms be left in the concrete. In general as the forms are removed, all projecting wire or metal devices which have been used for holding the forms in place, shall be removed or cut back at least 25 mm [1 inch] from the exposed surface of the concrete and the holes filled as required in Subsection 502.13.
- (e) Reuse of forms. When forms are to be reused they shall be maintained at all times for shape, strength, rigidity, water-tightness and surface smoothness. Any warped or bulged lumber shall not be used. Forms failing to meet these requirements will be considered unsatisfactory and shall not be used.

502.11 Placing Concrete.

- (a) General. Concrete shall not be placed until forms and reinforcing steel have been checked and approved. The forms shall be clean of all debris. The method and sequence of placing the concrete shall be approved before any concrete is placed.

All concrete shall be placed before it has taken its initial set and, in any case, within 30 minutes after mixing, except as modified under Subsection 502.07. Concrete shall be placed in such a manner as to avoid separation and segregation of coarse or fine portions of the mixture and shall be spread in horizontal layers.

Comparatively rich mixes, as directed by the Engineer, may be required initially in slabs and girders to facilitate the placing and compacting of the concrete around nests of reinforcing steel, so as to eliminate rock pockets or air bubbles. A sufficient number of men for the proper handling, tamping and operation of vibrators shall be provided to compact each batch before the succeeding one is dumped and to prevent the formation of joints between batches. Extra consolidation shall be done along all faces to obtain smooth surfaces. Care shall be taken to prevent mortar from spattering on structural steel, reinforcing steel and forms. Any concrete or mortar which becomes dried on the structural steel, reinforcing steel or forms shall be thoroughly cleaned off before the final covering with concrete. Following the placing of the concrete, all structural steel surfaces shall be thoroughly cleaned as required, with care not to injure any painted surfaces.

Concrete shall not come in contact with sea water during placing and for a period of 72 hours thereafter, except as follows:

For seal concrete or any authorized concrete deposited under water, the above requirements will not apply.

For concrete footings constructed in the dry and located entirely below low tide or final ground elevation, the requirement that concrete shall not come in contact with sea water for a period of 72 hours after placing will not apply.

Concrete in any section of a structure which has a depth greater than 450 mm [18 inches], shall be placed in approximately horizontal layers of such thickness that the entire surface may be covered and succeeding layers placed before the underlying layer has taken its initial set. Layers shall not exceed 450 mm [18 inches] in thickness and shall be so compacted as to become an integral part of the layer below. Every effort shall be made to produce a structure monolithic between the joints. However, should the placement be unavoidably delayed long enough to allow the underlying layer to take initial set or produce a so called "cold joint", the following steps shall be taken:

An incomplete horizontal layer shall be bulk-headed off to produce a vertical joint.

Horizontal joints shall be treated as required in this Subsection 502.11.

Should a cold joint occur in such a way as would produce a feather edge in the succeeding layer, inset form work shall be built to make the succeeding layer in a body of concrete not less than 150 mm [6 inches] thick.

Portland cement concrete with a high range, water reducing admixture shall not be placed when the concrete mix temperature is below 10 °C [50 °F] or above 29 °C [85 °F].

The concrete in superstructures shall be placed monolithically except when construction joints are shown on the plans or are authorized in accordance with approved details submitted by the Contractor. If the concrete in the stems of T-beams is to be placed independent of the slab section, the construction joint shall be located at the under side of the slab and the bond between stem and slab shall be a mechanical one. The bond shall be produced by embedding 38 by 89 mm [2 by 4 inch] wooden blocks having a length approximately 100 mm [4 inches] less than the width of the stem and placed horizontally at right angles to the centerline of the beam in the top surface of the concrete immediately following the completion of the concrete placement. To provide for the uniform spacing of the blocks and their ready removal when the concrete has taken a set sufficient to hold its form, the blocks shall be firmly nailed upon a board at a distance of 300 mm [1 foot] center to center. The blocks shall be thoroughly oiled to facilitate their ready removal from the concrete.

In arch spans, the order of construction or sequence of the work, as shown on the plans, shall be followed in the placing of concrete.

In no case shall the work on any section or layer be stopped or temporarily discontinued within 450 mm [18 inches] below the top of any face, unless the plans provide for a coping having a thickness less than 450 mm [18 inches], in which case at the option of the Engineer, the construction joint may be made at the under side of the coping. When placing concrete in columns for the bearing of girders, beams or slabs, the work shall not be continued above the top of the columns until a period of at least 2 hours has elapsed. Each column shall be examined for accumulations of "laitance" or other foreign matter which, if present, shall be removed in preparation for resuming the placing of concrete. Concrete in columns shall be placed in one continuous operation, unless otherwise directed.

Sloping top surfaces of abutment wings or retaining walls, when too steep to be struck off in the manner of horizontal surfaces, shall be treated as follows:

1. A series of form baffles shall be constructed on the top of and at right angles to the wing, to permit over filling the forms in steps. The spacing of the baffles shall depend upon the slope of the wing. The steeper the slope, the closer together the baffles shall be placed.
2. As soon as the concrete will support itself, the baffles shall be removed.

3. Immediately following removal of the baffles, the excess concrete shall be removed and the surface shall be finished with a wood float to the neat line at the top of the chamfer strips.

Fresh concrete, threatened with damage by rain shall be protected with a covering of canvas, tarpaulins, waterproof paper or by other approved means. Sufficient material for covering the work expected to be done in one day shall be on hand at all times for emergency use. The covering shall be supported above the surface of the concrete by suitable frames.

- (b) Chutes, Troughs, Pipes and Buckets. Sectional drop chutes or short chutes, troughs, pipes and buckets when used as aids in placing concrete, shall be arranged and used in such a manner that the ingredients of the concrete do not become separated or segregated. Where steep slopes are required, troughs and chutes shall be equipped with baffles or shall be short lengths that reverse the direction of movement. All chutes, sectional drop chutes, troughs, pipes and buckets shall be kept clean and free of coatings of hardened concrete by flushing thoroughly with water after each run. Water used for flushing shall be discharged clear of the concrete in place. Chutes, troughs, pipes and buckets shall be of metal or shall be lined with metal or its equal and when used for placing concrete shall extend as nearly as possible to the point of deposit. When buckets are used, they shall be placed as close as possible to the point of deposit before opening for discharge. Aluminum chutes, troughs, pipes or buckets are not acceptable and shall not be used.

When discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided.

Dropping the concrete a distance of more than 2 m [6 feet], unless confined by closed chutes or pipe or depositing a large quantity at any point and running it or forcing it along the forms will not be permitted. The concrete shall be deposited at or as near as possible to its final position. The coarse aggregate shall be worked back from the forms. After the initial set of the concrete and before the completion of the curing period, the forms shall not be jarred and no strain shall be placed on the ends of projecting reinforcement.

The placing of concrete shall be so regulated that the pressures caused by plastic concrete shall not exceed those for which the forms were designed.

- (c) Vibrating. Mechanical, high frequency internal vibrators shall be used, operating within the concrete, for compacting the concrete in all structures and precast and cast-in-place piles, with the exception of concrete placed under water, unless otherwise directed by the Engineer. The vibrators shall be an approved type, with a minimum frequency of 5,000 cycles per minute and shall be capable of visibly

affecting a properly designed mixture with a 25 mm [1 inch] slump, for a distance of at least 450 mm [18 inches] from the vibrator. A spare vibrator shall be available at all times during the placing of concrete.

Sufficient vibrators shall be used to consolidate the incoming concrete within 15 minutes after placing. Vibrators shall not be held against forms or reinforcing steel nor shall they be used for flowing the concrete or spreading it into place. Vibrators shall be so manipulated as to produce concrete that is free of voids, of proper texture on exposed faces and of maximum consolidation. Over-vibrating, tending to cause segregation, shall be avoided.

- (d) Unwatering Forms. Unless otherwise provided, all forms shall be unwatered before concrete is placed in them. Pumping will not be permitted from the inside of forms while concrete is being placed. Moving water shall not be permitted to come in contact with fresh concrete.
- (e) Depositing Concrete under Water. Unless permitted by the Engineer, no concrete shall be deposited under water except for cofferdam seals. Pumping will not be allowed within the cofferdam while concrete is being placed.

If concrete, other than for cofferdam seals, is permitted to be deposited under water, the proportion of cement to be used shall be increased by 25 percent and the extra cement shall be at the expense of the Contractor.

To prevent segregation, the concrete shall be placed carefully in a compact mass in its final position by means of a tremie or by other approved means and shall not be disturbed after being deposited. Bottom dump buckets will not be permitted. Special care must be exercised to maintain still water at the point of deposit. Concrete shall not be placed in running water. The method of depositing concrete shall be so regulated as to produce approximate horizontal surfaces. Each seal shall be placed in one continuous operation.

When a tremie is used, it shall consist of a tube not less than 250 mm [10 inches] in diameter, constructed in sections having flanged couplings fitted with gaskets or equivalent water tight couplings. The means of supporting the tremie shall be such as to permit free movement of the discharge end over the entire top of the seal and to permit its being lowered rapidly, when necessary to choke off or retard flow. The tremie shall be filled by a method that will prevent washing of the concrete. The discharge end shall be completely submerged in concrete at all times and the tremie tube shall be kept full to the bottom of the hopper. The flow shall be regulated by raising or lowering the tremie.

When the horizontal area of the tremie seal is large, several tremie hoppers shall be provided and positioned strategically to allow easy deposit of concrete near the

point where it is needed to avoid moving concrete horizontally through the water. The number of tremie hoppers and the work plan shall be approved by the Engineer.

All laitance or other unsatisfactory material shall be removed from the surface of the seal before placing additional concrete. The surface shall be cleaned by scraping, chipping or other means which will not injure the concrete.

The placing and unwatering of seal concrete within cofferdams shall be in accordance with Section 511 -- Cofferdams.

- (f) Construction Joints. Construction joints shall be located where shown on the plans or permitted by the Engineer. When the concrete is in sea water, except concrete cores for stone masonry, no horizontal construction joint will be permitted between low tide and high tide elevations. Construction joints shall be perpendicular to the principal lines of stress and in general, shall be located at points of minimum shear.

At horizontal construction joints, temporary gage strips having a minimum thickness of 38 mm [1½ inches] shall be placed inside the forms along all exposed faces to give the joints straight lines. The joint shall be so constructed that the surface of the concrete will not be less than 6 mm [¼ inch] above the bottom of the gage strip. Before placing fresh concrete, the temporary gage strip shall be removed, the surfaces of construction joints shall be thoroughly cleaned, drenched with water until saturated and kept saturated until the new concrete is placed. Immediately prior to placing new concrete the forms shall be drawn tight against the concrete already in place. When requested by the Engineer the old concrete surface shall be coated thoroughly with a very thin coating of neat cement paste or mortar. Concrete in substructures shall be placed in such a manner that all horizontal joints will be horizontal and if possible, in locations such that they will not be exposed to view in the finished structure.

Where vertical construction joints are necessary, reinforcing bars shall extend across the joint in such a manner as to make the structure monolithic. Special care shall be taken to avoid construction joints through paneled wing walls or other large surfaces which are to be treated architecturally. All vertical construction joints in abutments and retaining walls shall contain waterstops as shown on the plans, The waterstops shall be one continuous piece for each designated location.

Construction joints in the wearing surface shall be located where called for on the plans. No other construction joints will be allowed, except as is necessary to facilitate traffic or when continuous placement of the wearing surface is not possible, as determined by the Engineer.

All joints shall be formed in the manner detailed on the plans. The forms shall not be treated with oil or any other bond breaking material that will adhere to the concrete.

Sealing slots shall be provided at all joints in the wearing surface which are located directly over a slab construction joint.

Construction joints in the wearing surface not receiving a sealing slot shall be brushed with a neat cement paste immediately prior to making the adjacent concrete placement.

After the concrete has been cured, sealing slots shall be sandblasted with approved equipment to remove all laitance and foreign material on the surfaces of the slots. The bottom of the sealing slots shall receive an approved bond breaker. The joint shall then be filled within 3 mm [1/8 inch] of the surface with a poured sealant conforming to the following requirements and in accordance with the manufacturer's recommendations. When primer is required by the manufacturer to be used with the joint sealant furnished, it shall be applied as indicated by the instructions from the manufacturer.

The joint sealant supplied shall be a two component, polymer-type modified urethane. Both components shall be in liquid form and the combining ratio of components by volume shall be as recommended by the manufacturer.

The sealant shall be formulated to meet the requirements of Federal Specification SS-S-200D.

- (g) Concrete Wearing Surface. A separate concrete wearing surface shall be bonded to the supporting slab. No surface preparation of a new structural concrete slab shall begin before completion of the specified curing period.

The entire area of the deck surface and the faces of curb and barrier walls or other median devices, up to a height of 25 mm [1 inch] above the top elevation of the overlay, shall be cleaned to a bright, clean appearance which is free from curing compound, laitance, dust, dirt, oil, grease, bituminous material, paint and all other foreign matter. Air lines shall be equipped with effective oil traps. The cleaning of an area of the deck shall normally be performed within the 24 hour period preceding placement of the wearing surface. The cleaning shall be performed by dry sand blasting or other methods approved by the Engineer.

All debris from the cleaning operation shall be thoroughly removed by compressed dry air from the cleaned surfaces and adjacent areas. The cleaned areas shall be protected against contamination prior to placement of the wearing surface. Contaminated areas shall be recleaned by dry sand blasting. Prepared

areas which have not received the wearing surface within 36 hours shall be recleaned by dry air blasting 1000 kPa minimum [150 psi minimum].

The supporting slab shall preferably be dry but, in any case, shall be free of excess moisture prior to placement of the bonding grout.

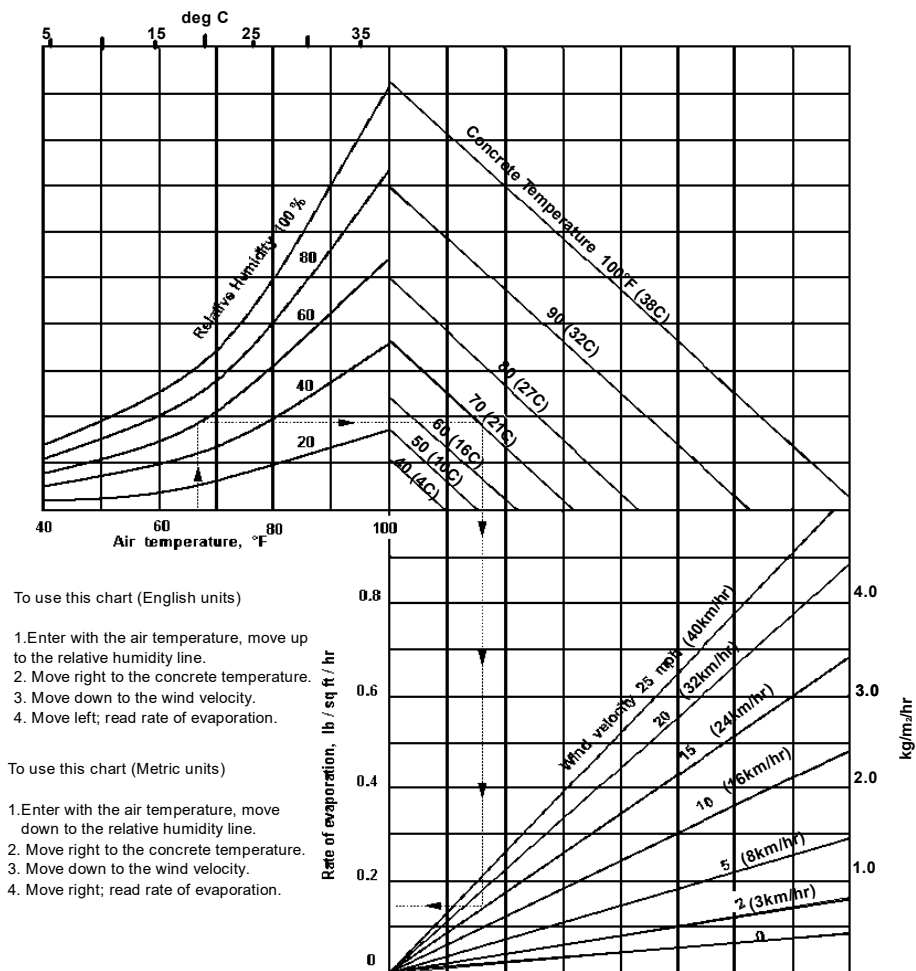
The vertical faces in contact with the wearing surface shall be broomed with bonding grout up to the elevation of the top of the wearing surface by brooming with the narrow width of a stiff bristled street broom. All horizontal surfaces in contact with the wearing surface shall receive a coating of bonding grout. Except as otherwise approved by the Engineer, the grout shall be applied from a metal or plastic container which has a series of 10 mm [3/8 inch] diameter holes uniformly spaced on the bottom and close to the bottom on the sides. As much as practicable, stiff, bristled, nylon, street brooms shall be used to brush the grout onto the surface and under the reinforcing steel. In general, the coating shall not exceed 3 mm [1/8 inch] in thickness. The rate of progress in applying grout shall be limited so that the grout does not become dry before it is covered with new concrete.

During delays in the surfacing operations, should the surface of the grout indicate an extensive amount of drying, additional grout shall be brushed on the area, as directed by the Engineer. In areas where the grout becomes thoroughly dried, the grout shall be removed by sand blasting or other methods as approved by the Engineer.

The bonding grout shall have portland cement and fine aggregate proportioned 1 to 1 by volume. The fine aggregate from which the material larger than 3 mm [1/8 inch] has been removed shall be the same source as used in the concrete. The cement and fine aggregate shall be measured separately in equal size containers. The fine aggregate shall be deposited in an approved mechanical mortar mixer prior to adding cement. Water shall be added in sufficient quantity to result in a workable consistency. Workable consistency is defined as using the minimum amount of water necessary to allow flow of most of the grout without segregation of the grout ingredients. No further water shall be added. The grout shall not be allowed to separate prior to placement. The cement to water contact time of the grout shall not exceed 30 minutes before it is placed. Any grout that has dried or become unworkable prior to application, as determined by the Engineer, shall not be incorporated into the work.

No wearing surface concrete placement shall be commenced if the combination of ambient air temperature, relative humidity, wind speed, and plastic concrete temperature, result in a surface moisture evaporation rate theoretically equal to, or greater than 1 kg/m²/hr [0.2 lbs/s.f./hr.] of exposed surface (Refer to the Hot Weather Concrete Wearing Surface Chart). The

temperature of the concrete shall not exceed 27 °C [80 °F] at the time of placement. The maximum temperature of the surface on which concrete will be placed shall be 32 °C [90 °F].



Rate of Evaporation from Concrete Surface Chart.
METRIC UNITS & ENGLISH UNITS

Hot Weather Concrete Wearing Surface Chart

502.12 Expansion and Contraction Joints. Expansion and contraction joints shall be located and constructed as shown on the plans.

- (a) Expansion Joints. In filled expansion joints, the thickness, shape and size of the filler to be installed shall be as shown on the plans. If preformed expansion joint filler is required, it shall be fixed firmly against the surface of the concrete already in place in such a manner that it will not be displaced when concrete is deposited against it and it shall be permanently secured to the concrete at one side of the joint by rust resistant nails cast in the concrete or other suitable means.

When necessary to use more than one piece of filler to cover any surface, the abutting pieces shall be placed in close contact and the joint between them shall be so treated as to prevent the entry of any concrete mortar from subsequent placements. Immediately after the forms are removed, the expansion joints will be inspected and any concrete or mortar that has sealed across the joint shall be cut neatly and removed. During construction when an opening of 3 mm [1/8 inch] or more appears in any joint over which any traffic passes, the opening shall be completely filled with an approved material, as directed.

Polyvinylchloride waterstops shall be placed in all vertical expansion joints. The waterstop shall be of one continuous piece for each designated location.

- (b) Contraction Joints. Polyvinylchloride waterstops shall be placed in all vertical contraction joints. The waterstop shall be of one continuous piece for each designated location. Bond shall be broken in all vertical contraction joints by a method approved by the Engineer.

502.13 Repairing Defects and Filling Form Tie Holes in Concrete Surfaces. After the forms and ends of form ties are removed, all porous areas, stone pockets, open or porous construction joints and holes left by the form ties shall be repaired.

All fins and irregular projections shall be removed from the following: Surfaces which are visible in the completed work; surfaces to be waterproofed; and the portion of face surfaces of substructure units which is below the final ground surface to a depth of 300 mm [12 inches], not including underwater surfaces.

In patching porous areas, all coarse or fractured material shall be chipped away until a dense uniform surface, exposing solid coarse aggregate is obtained. Feathered edges shall be cut away to form faces having a minimum depth of 25 mm [1 inch] perpendicular to the surface. All surfaces of the cavity shall be saturated thoroughly with water, after which a thin layer of neat cement paste shall be applied. The cavity shall then be filled with thick, reasonably stiff mortar, not more than 30 minutes old, composed of material of the same type and quality and of the same proportions as that used in the concrete being repaired. The surface of this mortar shall be floated

with a wooden float before initial set takes place and shall be neat and workmanlike in appearance. The patch shall be kept wet for a period of five days.

If the removal of defective concrete materially impairs the soundness or strength of the structure, the affected unit shall be removed and replaced by the Contractor at his expense.

The holes left by form ties, on the portions of substructure concrete which are to be permanently covered in the finished work, may be filled with an acceptable grade of plastic roofing cement when the temperature of the concrete or ambient temperature is below 2 °C [35 °F] and with the approval of the Engineer. Holes in the bottom of slabs caused by supporting hangers need not be filled.

502.14 Finishing Concrete Surfaces. Neat cement paste, dry cement powder or the use of mortar for topping or plastering of concrete surfaces will not be permitted.

- (a) Float Finish. A float finish for horizontal surfaces shall be achieved by placing an excess of concrete in the form and removing or striking off the excess with a template or screed, forcing the coarse aggregate below the surface. Creation of concave surfaces shall be avoided. After the concrete has been struck off, the surface shall be thoroughly floated to the finished grade with a suitable floating tool of wood, cork or other approved material.

Float finish, unless otherwise required, shall be given to all horizontal surfaces except those intended to carry vehicular traffic and those of curbs and sidewalks.

- (b) Structural Concrete Slab Structures, such as structural concrete deck slabs, wearing surfaces, top and bottom slabs of box culverts, approach slabs, rigid frame structures and simple slab spans, as applicable. Screed rails shall be set entirely above the finished surface of the concrete and shall be supported in a manner approved by the Engineer. Where shear connector studs are available, welding to the studs will be permitted. Where no studs are available other means of attaching the screed rail supports shall be provided. No welding will be permitted directly on the stringer flanges in tension areas, nor in areas subject to stress reversal, for attaching either screed rail supports or form supports of any type. Any welding in compression areas shall be approved by the Engineer.

Screed rail supports set in the concrete shall be so designed that they may be removed to at least 50 mm [2 inches] below the surface of the concrete. Voids created by removal of the upper part of the screed rail supports shall be filled with mortar having the same proportions of sand and cement as that of the slab or wearing surface. The mortar shall contain an approved additive in sufficient proportions to produce non-shrink or slightly expansive characteristics.

An approved bridge deck finishing machine complying with the following requirements shall be used, except as otherwise specified, for finishing structural concrete slab structures. The finishing machine shall have the necessary adjustments, built in by the manufacturer, to produce the required cross section, line and grade. The supporting frame shall span the section being cast in a transverse direction without intermediate support. The finishing machines shall be self-propelled and capable of forward and reverse movement under positive control. Provisions shall be made for raising all screeds to clear the screeded surface for traveling in reverse. The screed device shall be provided with positive control of the vertical position.

The finishing machine shall be self-propelled with either one or more oscillating screeds or one or more rotating cylinder screeds. An oscillating screed shall oscillate in a direction parallel to the centerline of the structure and travel in a transverse direction. A rotating cylinder screed shall rotate in a transverse direction while also traveling in the same direction. Either type of screed shall be operated transversely in overlapping strips in the longitudinal direction not to exceed 150 mm [6 inches]. One or more powered augers shall be operated in advance of the screed(s) and a drag (pantype) float shall follow the screed(s). For concrete placements less than 150 mm [6 inches] in depth, a vibratory pan(s) having a minimum of 3000 vpm (vibrations per minute) shall be operated between the oscillating screed(s) or rotating cylinder screed(s) and the power auger(s). For concrete placed in excess of 90 mm [3½ inch] but less than 150 mm [6 inch] thicknesses, hand-operated spud vibrators shall be used in addition to the machine vibratory pan(s).

The transversely operated rotating cylinder(s) of the bridge deck finishing machine shall be rotated such that the direction of the rotation of the cylinder(s) at the surface of the concrete is in accordance with the manufacturer's recommendations.

Hand-operated, vibrating screeds may be used on slab structures which are more than 300 mm [12 inches] below the roadway finish grade or have a length of 9 m [30 feet] or less.

The rate of placing concrete shall be limited to that which can be finished without undue delay and shall not be placed more than 3 m [10 feet] ahead of strike-off.

Concrete immediately in front of the power auger(s) of a bridge deck finishing machine shall be placed or cut to a depth no higher than the center of the rotating auger(s). The advance auger(s) shall strike off the concrete to approximately 6 mm [1/4 inch] above the final grade. The concrete shall then be consolidated with the vibrating pan(s) and then finished to final grade.

A small hand-held pan vibrator shall be required at edges and adjacent to joint bulkheads. In lieu of the hand-held pan vibrator equipment, the Engineer may approve small spud vibrator(s).

Where concrete placements are specified to be less than 5 m [16 feet] in width, the finishing machine may be a lightweight vibrating screed, and shall have the following features:

1. It shall be portable and easily moved, relocated, or adjusted by no more than four persons.
2. The power unit shall be operable without disturbing the screeded concrete.
3. It shall be self-propelled with controls which will allow a uniform rate of travel and by which the rate of travel can be increased, decreased or stopped.
4. It shall have controlled, uniform, variable frequency vibration, end to end.
5. It shall be fully adjustable for flats, crowns, or valleys.
6. The screed length shall be adjustable to accommodate the available work area.

When a lightweight vibrating screed is utilized, the concrete shall be placed or cut to no more than 13 mm [$\frac{1}{2}$ inch] above the finished grade in front of the front screed and the screed shall be operated such that at least 1 m [3 feet] of concrete is in position in front of the screed. The mat texturing of concrete wearing surfaces may be applied by workmen with a stiff, bristled, nylon street broom, or other methods approved by the Engineer, instead of the machine texture device described later on in this Subsection.

The Contractor shall furnish a minimum of two work bridges behind the finishing operation, capable of spanning the entire width of the deck and supporting at least a 225 kg [500 pound] load without deflection to the concrete surface, to be supported on the screed rails. These working bridges shall be used by the Contractor for touch-up and curing cover application and shall be available for inspection purposes. When the overall length of the structure is 18 m [60 feet] or less only one working bridge will be required.

Supporting slabs for bituminous wearing surfaces shall receive a light machine texture or the Contractor may use an approved barn or street broom and hand-finish by lightly and uniformly brooming at right angles to the centerline of the road. Texturing of supporting slabs for concrete wearing surface is not required.

On all concrete wearing surfaces, immediately following the machine float finishing, a machine texturing device shall be used. This machine texturing device may be completely separate from the screed finishing machine or it may be as a modification attachment and trailing the drag float. This texture device shall be of an approved open-pile, stiff bristle texturing mat used at right angles to the centerline of the road. This mat shall be rigidly attached so that it is draped onto the surface to obtain a uniform, medium texture.

On all concrete wearing surfaces, a 300 mm [1 foot] wide margin shall be finished adjacent to curbs with a magnesium float.

Immediately after screeding, floating and texturing, the surface of the concrete shall be tested for trueness, by the Contractor, with a 3 m [10 foot] straightedge and all irregularities corrected at once in order to provide a final surface within the tolerance required in the following table. The surface shall be checked both transversely and longitudinally. Any area that requires finishing to correct surface irregularities shall be retextured, which may be performed with a hand-operated texture mat wrapped in a roll or attached to a round or curved shape base.

The straightedges shall be furnished and maintained by the Contractor. They shall be fitted with a handle and all parts shall be made of aluminum or other light weight metal. The straightedges shall be made available for use by the Inspector when requested.

<u>Type of Surface</u>	<u>*Maximum deviation of surface inches] below a 3 m [10 foot] straightedge</u>
Concrete Wearing Surface	3 [1/8]
Concrete Slab Surfaces to be Covered by Membrane Waterproofing or Concrete Wearing Surfaces	6 [1/4]
Concrete Slab Surfaces with Integral Concrete Wearing Surface	6 [1/4]
Concrete Slab Surfaces to be Covered by Earth or Gravel	10 [3/8]
Concrete Surface of Box Culvert <u>Bottom Slabs</u>	<u>10 [3/8]</u>

*Allowance shall be made for crown, camber and vertical curve.

After the concrete has cured, the surface shall be tested again with the 3 m [10 foot] straightedge. Areas not within the above tolerance table shall be corrected as directed by the Engineer.

In the event of a delay during a concrete placement an approved evaporation retardant that forms a monomolecular film shall be sprayed on to the concrete which has been deposited and not screeded. This evaporation retardant may later be mixed into the concrete by the finishing machine.

No vehicles will be allowed, either directly or indirectly, on reinforcing steel prior to concrete placement.

- (c) Curb and Sidewalk Finish on Bridges. Curb and sidewalk finish is a float finish produced by using a short float of wood or other acceptable material, moved in small circles to produce a shell-like pattern on the surface of the concrete.

When a concrete curb is monolithic with a sidewalk or refuge walk and when the combined width is greater than 600 mm [2 feet], a 150 mm [6 inch] wide smooth margin shall be made along the top of the curb with a magnesium float.

Unless shown on the plans, the sidewalk area shall not be divided into sections by transverse grooves.

At all transverse construction and expansion joints, except where structural steel expansion plates are used, the edges of the joints, on the surface of the sidewalk, shall be finished with a sidewalk edging tool, 50 mm [2 inches] in width, with a 6 mm [$\frac{1}{4}$ inch] radius lip.

- (d) Form Surface Finish. The character of the materials used and the care with which forms are constructed and concrete placed shall be considered in determining the amount of rubbing required. If, through the use of first class form material, well constructed forms and the exercise of special care, concrete surfaces are obtained that are satisfactory to the Engineer, the Contractor may be relieved in part from the requirement of rubbing.

- 1. Ordinary Finish. An Ordinary Finish is defined as the finish left on a surface after the removal of the forms, the filling of all holes and the repairing of all defects. The surface shall be true and even, free from stone pockets and depressions or projections and of uniform texture.

Immediately following the removal of the forms, all defects shall be repaired as provided in Subsection 502.13.

All formed concrete surfaces shall be given an ordinary finish.

Repaired areas which do not meet the above requirements or areas which cannot be satisfactorily repaired to meet the requirements for ordinary finish shall be given a rubbed finish. When a rubbed finish is required on any part of a surface, the entire surface shall be given a rubbed finish.

2. Rubbed Finish. After removal of forms the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work the concrete shall be thoroughly saturated with water. Sufficient time shall have elapsed before wetting down to allow the mortar used in ordinary finish to become thoroughly set.

Surfaces to be finished shall be rubbed with a medium coarse carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in proportions as used in the concrete being finished. Rubbing shall be continued until all form marks, projections and irregularities have been removed, all voids filled and a uniform surface has been obtained. A thin layer of paste produced by this rubbing shall be left on the surfaces.

After all concrete above the surface being treated has been cast, the final finish shall be obtained by a second rubbing with a fine carborundum stone using only water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color. The paste produced by this second rubbing shall be carefully spread with a moist whitewash brush to form a very thin uniform coating upon the surface of the concrete.

After the final rubbing is completed and the surface has dried, it shall be rubbed lightly with clean and dry burlap to remove excess loose powder and shall be left free from all unsound patches, paste, powder and objectionable marks. This finish shall result in a surface of smooth texture and uniform color.

No surface finishing shall be done in freezing weather or when the concrete contains frost. In cold weather the preliminary rubbing necessary to remove the inert sand and cement materials and the surface irregularities may be done without the application of water to the concrete surfaces.

The following portions of concrete structures shall be given a rubbed finish unless otherwise indicated on the plans or in the Special Provisions:

Railings and posts, including parapet walls-All surfaces except the bottoms of rail bars.

Superstructures-Exterior vertical surfaces except below copings and except where a protective coating is required.

Abutment wings and retaining walls-Top and the back to 450 mm [18 inches] below top.

For roadway grade separation structures and their approaches, in addition to the above, the following surfaces shall also be given a rubbed finish unless otherwise indicated on the plans or in the special provisions.

Retaining walls and the breast and wing walls of abutments-face surfaces to 300 mm [12 inches] below the finished ground line.

Piers-All vertical surfaces and the underside of overhanging portions of caps, except that for overpass structures, the piers beyond the outside limits of the roadway pavement, the vertical surfaces on the back which are not visible from the roadway or sidewalk will not require a rubbed finish.

If, in the opinion of the Engineer, the general appearance of a concrete structure, due to the excellence of workmanship, cannot be improved by a rubbed finish, this requirement may be waived.

502.15 Curing Concrete. All concrete surfaces shall be kept wet with clean fresh water for at least 7 days after placing of concrete, except that, with the approval of the Engineer, concrete wearing surfaces may be limited to 4 days.

All slabs and wearing surfaces shall be water cured only and kept continuously wet for the entire curing period by covering with one of the following systems:

- (a) Two layers of wet burlap,
- (b) Two layers of wet cotton mats,
- (c) One layer of wet burlap and either a polyethylene sheet or a polyethylene coated burlap blanket,
- (d) One layer of wet cotton mats and either a polyethylene sheet or a polyethylene coated burlap blanket.

Except as otherwise specified, curing protection for slabs and wearing surfaces shall be applied within 30 minutes after the concrete is screeded and before the surface of the concrete has lost its surface "wetness" or "sheen" appearance. The first layer of either the burlap or the cotton

mats shall be prewetted and shall be applied as soon as it is possible to do so without damaging the concrete surface. When the first layer of wet burlap or wet cotton mats cannot be placed without damage to the new concrete surface within the 30 minutes after screeding of any concrete, or when, in the opinion of the Engineer, wind, temperature, or other conditions exist which would contribute to rapid drying of the concrete surface, an approved evaporation retardant that forms a monomolecular film shall be applied.

Surfaces of concrete placements containing silica fume additive shall be coated with an approved evaporation retardant immediately after finishing and texturing of the concrete surface and the application of wet burlap or wet cotton mats shall be made within 15 minutes after the finishing of the concrete surface.

The application rate, the desired equipment and the mixing and application procedures for an approved evaporation retardant shall be as designated by the manufacturer. The evaporation retardant shall be as designated by the manufacturer. The evaporation retardant shall be applied before the concrete surface has lost all its surface "wetness". Successive applications or heavier applications of this evaporation retardant shall be applied as necessary to retain the required surface "wetness" appearance.

The covering of concrete wearing surfaces, decks, curbs, and sidewalks shall be kept continuously wet for the entire curing period by the use of soaker hoses. The soaker hoses shall circulate water continuously and shall be located to insure a completely wet concrete surface for the entire curing period.

At the option of the Contractor, an approved curing compound may be used on approach slabs below grade and bottom slabs, to provide the initial curing protection to the concrete in place of the above procedure. After the concrete surface has developed a firm set, it shall be covered with at least one layer of burlap or other suitable fabric and kept continuously wet for the entire curing period. Polyethylene sheets shall not be used directly on the concrete, but may be placed over the fabric cover to prevent drying.

All other surfaces, if not protected by forms, shall be kept thoroughly wet either by sprinkling or by the use of wet burlap, cotton mats or other suitable fabric until the end of the curing period. If wood forms are allowed to remain in place during the curing period, they shall be kept moist at all times to prevent openings at joints. Polyethylene sheets shall not be used on the concrete, but may be placed over the fabric cover to prevent drying.

When liquid-forming compounds for curing concrete are used they shall serve as the initial protection and curing as well as final curing except as stated above. Prior to transfer from containers to application equipment, the curing compound shall be agitated by a method approved by the Engineer, to assure uniformity of the mixture or solution.

The compound shall be applied immediately following final finishing and before any marked dehydration of the concrete or surface checking occurs.

The curing compound shall be applied continuously by an approved pressure spraying or distributing equipment at a rate necessary to obtain an even, continuous membrane, but at a rate of not less than 0.2 L/m² [1 gallon per 200 square feet] of surface.

If rain injures the film before it has dried sufficiently to resist damage or if the film is damaged in any other way, a new coat of material shall be applied to the affected area. The treated surface shall be protected from injury for a period of 7 days.

When the ambient temperature is expected to fall below 2 °C [35 °F], the Contractor shall make suitable provision to maintain the temperature of the concrete and its surface above the temperatures required in Subsection 502.08.

For concrete wearing surfaces the temperature of the concrete and its surfaces shall be kept above 10 °C [50 °F] for 4 days. Any day during which the concrete temperature falls below 10 °C [50 °F] shall not be counted as a curing day. If at any time during the curing period the ambient temperature in the shade falls below 2 °C [35 °F], and the concrete surface is not protected in an approved fashion, the work may be considered as being unsatisfactory and rejected. If the concrete temperature during the curing period falls below 2 °C [35 °F], regardless of the protection provided, the work may be considered as being unsatisfactory and rejected.

Special attention shall be given by the Contractor to the proper curing of concrete handrails and all surfaces requiring rubbed finishes.

502.16 Loading Structures and Opening to Traffic. In general, no superstructure concentrated loads such as structural steel beams, girders and trusses shall be placed upon finished concrete substructures until the concrete has been in place for a period of seven days.

No load or work will be permitted on reinforced concrete superstructure slabs of composite construction for a period of 7 days, following the placement of the concrete. However, depending on curing conditions, after a shorter period of time the Engineer may permit handwork for form construction and setting stone bridge curb. No curbing or other materials shall be stored on the bridge during the 7 day period, except that if handwork is permitted, curb stones may be stored in a line near to their final location until ready to be set.

Neither traffic nor fill material shall be allowed on superstructures of concrete bridges or culverts for a period of from 14 to 21 days after the placing of the concrete has been completed, dependent upon conditions as specified in Subsection 502.10 and with the approval of the Engineer.

No traffic will be allowed on the cured concrete of a concrete wearing surface until after a one day air drying period has transpired subsequent to the removal of the curing.

Concrete approach slabs at the end of structures may be opened to traffic, with the approval of the Engineer, 10 days after the placing of the concrete, provided that a minimum thickness of 150 mm [6 inches] of gravel, free of stones greater than 75 mm [3 inches] in size, is placed over the slab for traffic to travel on.

502.17 Bridge Drains and Incidental Drainage. All drains shall be accurately placed at the locations shown on the plans or authorized and adequate means provided for securely holding them in the required positions during the placing of concrete.

Bridge drains shall be galvanized and shall conform to the details shown on the plans and the requirements of Subsection 711.04 - Bridge Drains.

Drains or weep holes through abutments and retaining walls shall be pipe of the size and shape shown on the plans and shall be of approved cast iron, tile, fiber or other material that will maintain its shape and alignment during placing of concrete.

For the purpose of providing drainage for any moisture which may collect between the floor slab and the bituminous concrete roadway surface, approved 25 mm [1 inch] inside diameter plastic tube drains shall be installed at the low points of the slab surface, adjacent to the end dam or dams. The exact location will be determined in the field by the Engineer and the discharge from them shall be such as to clear the bridge seats and any other portion of the structure in their proximity. The tops of the drains shall be depressed 10 mm [3/8 inch] below the surface of the slab and the outlets shall project 50 mm [2 inches] below the underside of the slab. Care shall be exercised not to cover the tops of the drains with the required floor slab membrane waterproofing, when it is installed.

502.18 Method of Measurement.

- (a) Structural concrete satisfactorily placed and accepted will be measured by the cubic meter [cubic yard], in accordance with the dimensions shown on the plans or authorized changes in the plans, or as one lump sum unit, as indicated in the schedule of items.

Structural Concrete for jacketing or capping of rough irregular stone masonry abutments, retaining walls and piers, if directed by the Engineer, may be measured by the cubic meter [cubic yard] as determined from the theoretical yield of the design mix or in the case of readymixed concrete, by delivery ticket, in accordance with paragraph (e) of this Subsection.

- (b) The limits to be used in determining the quantities of the aforementioned structural concrete items for the purpose of arriving at a lump sum price will be as follows:

1. Structural Concrete Superstructure Slabs, Structural Concrete Roadway and Sidewalk Slabs on Steel Bridges and Structural Concrete Superstructure T-beam Type. The limits will be the entire concrete superstructure of the concrete portion of the superstructure, outside to outside, both transversely and longitudinally.
 2. Structural Concrete Wearing Surfaces. The limits will be the entire concrete wearing surface bounded transversely by the roadway curbs and longitudinally by the extreme ends.
 3. Structural Concrete Box Culverts. The limits will be the entire structure, meaning the bottom floor slab, abutments, wings, superstructure floor slab and headwalls or curbs.
 4. Structural Concrete, Approach Slabs. The limit will be the entire approach slab or slabs, as shown on the plans.
 5. Structural Concrete, Abutments and Retaining Walls, Structural Concrete, Abutments and Retaining Walls (placed under water), Structural Concrete Piers, and Structural Concrete Piers (placed under water). The limits will be the entire concrete substructure unit or units, from the bottom of the footing to the top of the unit, and outside to outside, both transversely and longitudinally, except for the portion to be placed under water, as indicated on the plans, which will be the limits of the concrete unit or units, outside to outside, transversely, longitudinally, and vertically.
 6. Structural Concrete Rigid Frame Structures. The limits will be the entire concrete structure, meaning the frame walls and top slab. Also included within the limits for payment, unless otherwise shown on the plans, are concrete curbs, end posts, bottom slab, wingwalls and headwalls.
 7. Structural Concrete Culvert Endwalls. The limit will be the entire concrete endwall or endwalls, as shown on the plans.
- (c) No deduction will be made for the volume of concrete displaced by structural steel, reinforcing steel, pile heads, expansion joint material, drains, chamfers on corners, inset panels of 38 mm [1½ inches] or less in depth, pipes, weep holes and authorized openings for utilities of 0.2 m³ [¼ cubic yard] or less in volume, when any of these items occur in structural concrete which is to be paid for on a cubic meter [cubic yard] basis.
- (d) When foundations for concrete structures are required to be at a definite elevation within rock excavation, as shown on the plans or otherwise designated, the quantity to be measured will be the number of cubic meters [cubic yards] of

concrete actually and satisfactorily placed above a plane at 300 mm [1 foot] below the above specified plan elevation and within the neat lines of the structure as shown on the plans or on authorized changes in the plans. If the ledge rock is excavated below the plane at 300 mm [1 foot] below the plan elevation, without authorization, then this space shall be replaced with concrete of the same composition as required for the structure foundation but will not be measured for payment.

- (e) Concrete for jacketing or capping of stone masonry abutments, retaining walls and piers, when the masonry is rough and irregular, making it impracticable to measure the quantity by the three dimensional method, the quantity in cubic meters [cubic yards] up to the elevation of the stone masonry, may be determined from the theoretical yield, in cubic meters [cubic yards], computed from the design mix. When readymixed concrete is used for this type of construction delivery tickets as specified in this Section for each load satisfactorily delivered and placed, will be used for measurement purposes.
- (f) Silica fume additive will be measured by the lump sum or by the kilogram [pound], as designated, complete and accepted.

502.19 Basis of Payment. The accepted work done under structural concrete, of the classes and for the types of work required, will be paid for at the contract unit price per cubic meter [cubic yard], or at the contract lump sum price, for the respective contract items involved. Payment for both the unit price and the lump sum price items will be full compensation for furnishing and installing bridge drains, water stops, expansion joint filler, fiber or plastic tube drains, roofing felt, asphalt for painting or covering various type of joints, all required sandblasting, bonding, curing and joint sealing and all incidentals necessary to complete the work satisfactorily.

No price adjustments will be made for differences between estimated quantities shown on the plans for lump sum items and the actual quantities. It will be the responsibility of the Contractor to verify the estimated quantities prior to submitting bid documents.

No direct payment will be made for concrete admixtures with the exception of silica fume additive. Silica fume additive will be paid for at the contract lump sum price or price per kilogram [pound] as designated which price will be full compensation for all material, labor, and incidentals necessary to complete the work satisfactorily.

Payment for structural concrete culvert connection shall include drilling and grouting the dowels into the existing headwall and excavation. Reinforcing will be paid for under Pay Item 503.12, Reinforcing Steel, Fabricated and Delivered and Pay Item 503.13, Reinforcing Steel, Placing.

Reinforcing steel, railings, stone curbs and any material which may be required for bridge lighting systems, will be measured and paid for separately as provided in the appropriate Sections.

Payment will be made under:

Pay Item	Pay
Unit	
502.21 Structural Concrete, Abutments and Retaining Wall	cubic meter [Cubic Yard]
502.219 Structural Concrete, Abutments and Retaining Walls	Lump Sum
502.22 Structural Concrete, Abutments and Retaining Walls (placed under water)	cubic meter [Cubic Yard]
502.229 Structural Concrete, Abutments and Retaining Walls (placed under water)	Lump Sum
502.23 Structural Concrete Piers:	cubic meter [Cubic Yard]
502.239 Structural Concrete Piers	Lump Sum
502.24 Structural Concrete Piers (placed under water)	cubic meter [Cubic Yard]
502.249 Structural Concrete Piers (placed under water)	Lump Sum
502.25 Structural Concrete Superstructure Slab	Lump Sum
502.26 Structural Concrete Roadway and Sidewalk Slab on Steel Bridges	Lump Sum
502.27 Structural Concrete Superstructure T-beam Type	Lump Sum
502.28 Structural Concrete Rigid Frame Structures	cubic meter [Cubic Yard]
502.289 Structural Concrete Rigid Frame Structures	Lump Sum
502.29 Structural Concrete Wearing Surface of Bridges	Lump Sum
502.30 Structural Concrete Box Culvert	Lump Sum
502.31 Structural Concrete Approach Slab: ____	Lump Sum
502.32 Structural Concrete Culvert Endwall	cubic meter [Cubic Yard]
502.329 Structural Concrete Culvert Endwall	Lump Sum
502.33 through 502.39 Vacant	
502.40 Structural Concrete Box Culvert	cubic meter [Cubic Yard]
502.41 Structural Concrete Superstructure Slab	cubic meter [Cubic Yard]
502.42 Structural Concrete Roadway and Sidewalk Slab on Steel Bridges	cubic meter [Cubic Yard]
502.43 Structural Concrete Superstructure T-beam Type	cubic meter [Cubic Yard]
502.44 Structural Concrete Wearing Surface on Bridges	cubic meter [Cubic Yard]
502.45 Structural Concrete Approach Slab	cubic meter [Cubic Yard]
502.46 Structural Concrete Culvert Connection	cubic meter [Cubic Yard]
502.4711 Silica Fume Additive	Lump Sum
502.4712 Silica Fume Additive	kilogram [Pound]

SECTION 503 -- REINFORCING STEEL

503.01 Description. This work shall consist of furnishing and placing reinforcement, either plain or epoxy coated, in accordance with these specifications and in conformity with the plans.

MATERIALS

503.02 Materials. Materials shall meet the requirements of the following Subsections of Division 700 -- Materials:

Reinforcing Steel	709.01
Welded Steel Wire Fabric	709.02

503.03 Schedule of Material. When steel schedules are not furnished by the Department, the Contractor shall submit order lists and bending diagrams to the Engineer for approval. No material shall be ordered until these lists have been approved; however, such approval shall not relieve the Contractor of full responsibility for the satisfactory completion of this item.

CONSTRUCTION REQUIREMENTS

503.04 Protection of Material. Steel reinforcement shall be stored on skids or other supports above the ground and protected at all times from injury and surface contamination.

Epoxy-coated bars shall be stored at the construction site a minimum of 300 mm [12 inches] above the ground surface and above any vegetation growth. The storage supports shall be racks or platforms constructed of wood or other materials, with padded facing on the contact areas. Bundles of bars shall be stored on racks or platforms in a single layer. Each bundle shall be placed on the rack or platform out of contact with adjacent bundles.

If it is expected that epoxy coated bars will be required to be stored outdoors for a period in excess of three months they shall be stored or covered in such a way as to protect such bars from ultraviolet radiation.

503.05 Fabrication. The inside diameter of bends for 15 M [Number 5] bar and smaller stirrups and ties shall not be less than 4 times the diameter of the stirrup or tie bar. For all other bars up to and including 25 M [Number 8] bar, the inside diameter of bend shall not be less than 6 times the diameter of the bar. For bars larger than 25 M [Number 8], the inside diameter of bend shall not be less than 8 times the diameter of that bar. Unless otherwise specifically authorized, bars shall be bent cold.

Bending tolerances shall be in conformance to that established in the latest edition of the "Manual of Standard Practice of the Concrete Reinforcing Steel Institute" and the "Detailing Manual of the American Concrete Institute".

503.051 Epoxy Coating. Reinforcing steel, specified on the design drawings to be epoxy coated, shall meet the requirements of ASTM A775/A775M, Epoxy-Coated Reinforcing Steel Bars and the following requirements:

- (a) The Contractor shall furnish a written certification that at the point of application of the coating and at the reinforcing bar shop the coating, the coated bars, and the handling and packaging of the coated bars, meet all the requirements specified in par. 4.2.1 and par. 14.1 of ASTM A775/A775M, and Subsection 503.053 of these specifications.

- (b) Patching material as specified in par. 4.4 of ASTM A775/A775M, shall be supplied for both shop and field patching of the coated reinforcing steel. The patching material shall be supplied as required, but at not less than the following rates:

10 M to 15 M [#3-#5] bars 1 L per 4800 m [1 quart per 15000 ft.] of bar or fraction thereof

20 M to 30 M [#6-#9] bars 1 L per 2550 m [1 quart per 8000 ft.] of bar or fraction thereof

35 M [#10] up 1 liter per 1900 m [1 quart per 6000 ft.] of bar or fraction thereof

- (c) All testing shall be as specified in ASTM A775/A775M, except that the frequency of testing for adhesion of the coating shall be two bars of each size out of all bars coated with each individual batch or lot of epoxy resin, or two bars of each size out of all bars coated in an eight hour period, whichever is greater.
- (d) If a reinforcing bar fabrication shop uses previously stockpiled bars to supply the requirements of this contract, the fabrication shop shall furnish copies of all certificates required to be furnished by the coating applicator under (a) above. The certificates furnished shall be directly traceable to the actual bars used through batch numbers, order numbers or similar information. If such certification is not available, the Department reserves the right to perform the tests specified under ASTM Specification A775/A775M at the expense of the fabrication shop. For bars supplied from stock, the fabrication shop shall supply all patching material specified under (b) herein.
- (e) When the estimated quantity of epoxy-coated reinforcing bars exceeds 18,000 kg [40,000 pounds], the Contractor shall notify the Engineer at least one week prior

to the start of the coating application, so that the Engineer or his designated representative may be present at the beginning of the application of the epoxy coating.

503.052 Patching of Epoxy Coating. Patching required at the point of application of the epoxy coating shall be done in conformity with the requirements of ASTM A775/A775M.

At the reinforcing steel fabrication shop and at the job site, all nicks, cuts, scratches, cracks, abrasions, sheared ends etc., visible to the naked eye, shall be repaired using patching material supplied as specified under Subsection 503.051(b). To the greatest extent possible, repairs to each day's production at the fabrication shop and each day's placement at the job site shall be done before the end of each working day. If, damaged areas do become rusted or contaminated with foreign matter, the areas shall be cleaned by sandblasting or an equally effective method, such that all visible rust and/or foreign matter is removed prior to patching.

503.053 Packaging and Handling of Epoxy-Coated Bars. All handling of epoxy-coated reinforcing bars by mechanical means shall be done by equipment having padded contact areas, or by the use of nylon webbing slings. The use of chains or wire rope slings shall not be allowed, even when used with padding. All bundles of coated bars shall be lifted with a strong back, spreader bar, multiple supports or a platform bridge to prevent bar-to-bar abrasion from sags in the bundles. Support points during lifting or transporting of bundled epoxy-coated bars shall be spaced at a maximum of 4.5 m [15 feet].

Bundled bars shall be strapped together with nonmetallic or padded straps in a manner to prevent bar-to-bar abrasion due to relative movement between bars.

Bars loaded for transport shall be loaded and strapped down in a manner that will prevent damage from motion and vibration, to the greatest extent possible. Bundles of bent bars shall be transported strapped to wooden platforms or shall be crated. All individual bundles and layers of bundles shall be separated and supported by dunnage.

Individual bars shall be handled in a manner that prevents, damage to the coating due to abrasion or impact, and at no time shall any bar be moved by dragging over any surface, including other reinforcing bars. Sufficient personnel shall be assigned to assure that the above is complied with.

503.06 Placing and Fastening. All steel reinforcement shall be accurately placed in the positions shown on the plans and shall be firmly held there during the placing and setting of the concrete. Immediately before placing concrete, steel reinforcement shall be free from all foreign material which could decrease the bond between the steel and concrete. Such foreign material shall include but not be limited to dirt, loose mill scale, excessive rust, paint, oil, bitumen and dried concrete mortar.

Bars shall be fastened together at all intersections except where spacing is less than 300 mm [1 foot] in either direction, in which case, fastening at alternate intersections of each bar with other bars will be permitted providing this will hold all the bars securely in position. This fastening may be tightly twisted wire or by tack welding when permitted by the Engineer. All tack welding shall be in accordance with Section 504 -- Structural Steel. No tack welding for fastening or supporting reinforcing steel in areas of high tensile stresses will be permitted. Welding on epoxy-coated reinforcing steel will not be permitted under any condition.

In general, no welding will be permitted on the main reinforcing steel of superstructure slabs.

Proper distances from the forms shall be maintained by means of stays, blocks, ties, hangers or other approved means. Blocks used for this purpose shall be precast portland cement mortar blocks of approved shape and dimensions or approved metal or plastic chairs. Layers of bars may be separated by precast portland cement mortar blocks or other approved devices. The use of pebbles, pieces of broken stone or brick, metal pipe or wooden blocks shall not be permitted. The placing of reinforcement as concrete placement progresses, without definite and secure means of holding the steel in its correct position, shall not be permitted except in the case of welded steel wire fabric or bar mats.

Epoxy-coated reinforcing bars supported on 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 50 mm [2 inches] from the point of contact with the reinforcing bars. Reinforcing bars used as support bars shall be epoxy-coated. In walls, spreader bars shall be epoxy-coated.

Tie wire for epoxy-coated reinforcing steel shall be soft annealed wire that has been nylon, epoxy or plastic coated.

Field bending or cutting of epoxy-coated reinforcing bars will not be allowed, unless otherwise indicated on the plans or permitted by the Engineer. All damaged coating areas that result from permitted bending or cutting shall be repaired in accordance with the patching requirements.

Bars in bridge seats shall be placed so as to clear anchor bolts.

When specified on the contract plans, reinforcing steel shall be anchored into drilled holes.

The anchoring material shall be one of the products listed on the Maine Department of Transportation's list of Prequalified Type 3 Anchoring Materials. Installation shall be in conformance with the manufacturer's recommendations.

At each location, existing reinforcing will be located by the Engineer, where appropriate, to avoid drilling through existing bars. Location adjustments, if necessary, will be made by the Engineer.

Minimum embedment lengths of reinforcing bars will be determined by the Engineer to comply with the embedment lengths determined by the anchoring material selected. The reinforcing steel lengths indicated in the contract plans may be cut, at the Contractor's option, to the determined minimum embedment lengths.

Reinforcement shall be inspected and approved by the Engineer before any concrete is placed.

503.07 Splicing. Reinforcing bars shall be spliced in accordance with the requirements of this subsection, and in the locations shown on the plans. No modifications of, or additions, to the splice arrangements shown on the plans shall be used without the Engineer's prior approval. Any additional splices authorized shall be staggered as much as possible. All splices shall be made in a manner, and using fixtures, that will assure maintaining not less than 75 percent of the clear concrete cover and not less than 75 percent of the minimum clear distance to other bars, required for the unspliced bar.

Lapped splices shall be made by placing the bars in contact and wiring them together.

Splices using mechanical couplers may be made by any device approved by the Engineer and satisfying the following requirements:

- (a) Tension Couplers. Couplers shall be able to develop 1.25 times the theoretical yield strength of the spliced bar in tension. Bolted and wedge- lock type couplers will not be allowed.
- (b) Compression Couplers. Couplers shall be capable of maintaining the spliced bars in alignment prior to and during concrete placement. For reinforcing bars designed to act in compression the individual bar ends shall be within 1½ degrees of being "square" to the final 300 mm [12 inches] of the bar, abutting bar ends shall be in contact and the angle of the gap between abutting bar ends shall be 3 degrees or less.
- (c) Any mechanical coupler using a threaded splicer and dowel in combination, and requiring a lapped splice with the reinforcing bars, shall have a minimum length of lap as shown in the following table.

METRIC UNITS

<u>Required Lap in Millimeters</u>
<u>Bars Size</u>

Splice Type		10M	15M	20M	25M	30M	35M
(1) Tension							
	Deformed	300	550	700	1200	1500	2350
	Epoxy Coated	500	800	1050	1800	2330	3550
Compression	All Bars	300	500	600	800	900	1100

ENGLISH UNITS

		Bar Size								
Splice Type		#3	#4	#5	#6	#7	#8	#9	#10	#11
(1)										
Tension	Deformed	12"	17"	21"	27"	36"	47"	60"	76"	93"
	Epoxy									
	Coated	19"	25"	31"	40"	54"	71"	90"	114"	139"
	All									
Compression	Bars	12"	15"	19"	23"	27"	30"	34"	38"	43"

(1) Use Tension splice unless otherwise noted on the plans.

Welded splices may be made by the "Thermit" process or, with the approval of the Engineer, by the shielded metal arc welding process or the self-shielded flux-core arc welding process. The latter two processes shall be used in strict conformance with the requirements of the latest edition of AWS D1.4 "Structural Welding Code - Welding Reinforcing Steel" and any applicable provisions of Supplemental Specification, Section 504, Structural Steel (Welding). The Contractor shall submit complete details of his proposed method of making welded splices for the Engineer's approval.

503.08 Lapping. Sections of welded steel wire fabric shall overlap and be securely fastened to adjoining sections. All laps shall be in accordance with Wire Reinforcement Institute Manual of Standard Practice.

Bar mats shall be spliced as required for the individual bars.

503.09 Substitution. Substitution of different size bars shall not be permitted except with the written authorization of the Engineer.

503.10 Method of Measurement. Reinforcing steel, both plain and epoxy-coated, shall be measured by the computed number of kilograms [pounds] of steel reinforcement authorized.

Weights will be computed on the following basis:

For structural steel . . Nominal weight of the section.

For Bars:

METRIC UNITS

Size of Bars	kg/m
10 M	0.785
15 M	1.570
20 M	2.355
25 M	3.925
30 M	5.495
35 M	7.850
45 M	11.755
55 M	19.625

ENGLISH UNITS

Size Plain	1/4"	"	1/2"	"	3/4"
Size Deformed	#3	#4	#5	#6	
Wt. per foot in pounds	.167	.376	.668	1.043	1.502
Size plain	7/8"	1"	1 1/8"	1 1/4"	1 3/8"
Size Deformed	#7	#8	#9	#10	#11
Wt. Per foot in pounds	2.044	2.670	3.400	4.303	5.313

For welded steel wire
fabric:

METRIC UNITS

Sizes in mm	152x152	76x152	102x102	152x152
Gauge	W1.4xW1.4	W1.4xW1.4	W1.4xW1.4	W2.9xW2.9
Wt. in kg/m ²	1.02	1.46	1.51	2.05

ENGLISH UNITS

Size in inches	6x6	3x6	4x4	6x6
Gauge	W1.4xW1.4	W1.4xW1.4	W1.4xW1.4	W2.9xW2.9

Wt. in lbs.
per 100 sq.ft. 21 30 31 42

For other sizes of fabric, the commercially recognized weights will be used.

No addition to, or deduction from the theoretical weight per meter [foot] of the uncoated bars will be made because of additional requirements for blast cleaning and epoxy coating of the bars.

Lapped splices and splices using mechanical means or welding, authorized at the Contractor's request, will not be measured for payment. Splices using mechanical means or welding, shown on the design drawings, will be measured as the number of splices of each kind satisfactorily made and accepted.

503.11 Basis of Payment. The accepted quantity of reinforcing steel will be paid for at the contract unit price per kilogram [pound] for each item involved, completed and accepted.

The accepted quantity of epoxy-coated steel reinforcing bars will be paid for at the contract unit price per kilogram [pound] for each item involved, completed and accepted, and all additional expenses that may be incurred by the Contractor or his suppliers as a result of the requirements in these specifications will be considered incidental to, and included in, the contract unit price per kilogram [pound].

The accepted quantity of mechanical and/or welded splices will be paid for at the contract unit price each, completed and accepted, for each type specified.

Payment will not be made for any materials used to hold reinforcement in place nor for extra weight due to substitutions and splices made for the Contractor's convenience.

When reinforcing steel is specified to be anchored into drilled holes, no additional payment will be made for drilling and anchoring reinforcing steel or cutting of reinforcing steel to embedment lengths.

Payment will be made under:

Pay Item	Pay Unit
503.12 Reinforcing Steel, Fabricated and Delivered [Pound]	kilogram
503.13 Reinforcing Steel, Placing [Pound]	kilogram
503.14 Epoxy-Coated Reinforcing Steel, Fabricated and Delivered	kilogram [Pound]

503.15 Epoxy-Coated Reinforcing Steel, Placing [Pound]	kilogram
503.16 Welded Steel Wire Fabric Complete in place [Pound]	kilogram
503.17 Mechanical/Welded Splice	Each

SECTION 504 -- STRUCTURAL STEEL

504.01 Description. This work shall consist of detailing, fabricating, shop painting, and erecting the structural steel portions of bridges, including self-lubricating bronze or copper-alloy bearing and expansion plates and other related materials as required under this contract.

The type of construction, whether bolted, welded or a combination thereof, shall be as shown on the plans. Workmanship and finish shall be such as to meet or exceed the requirements of these specifications in all respects, and shall be equal to the best general practice in modern bridge fabrication shops.

504.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Structural Steel	713.01
High Strength Bolts	713.02
Preformed Pads	713.03
Bronze or Copper-Alloy Bearing and Expansion Plates	713.04
Cold-Finished Carbon Steel Shafting	713.05
Castings	713.06
Metal Bridge Paint (Shop Coat)	708.02

504.03 Drawings. The Contractor shall prepare shop detail, erection and any other necessary working drawings in accordance with the requirements of Subsection 105.02. All shop drawings shall be detailed using the same units used on the plans.

Substitutions of sections, materials or details, differing from those shown on the contract plans or on previously approved drawings prepared by the Contractor, shall be made only when approved by the Engineer.

All changes and revisions to the approved working drawings shall be subject to further approval by the Engineer in accordance with Subsection 105.02.

Preferred plan dimensions shall be 841 mm [36 inches] in length by 594 mm [22 inches] in width, with a border line located 15 mm [½ inch] inside the edge on the top, bottom and right end

of the plans and 71 mm [2 inches] from the edge on the left end, and shall show the state's project number in the title block. Alternate plan dimensions may be used provided the plan width does not exceed 594 mm [24 inches].

504.04 Design. Design, detail and load requirements shall conform to Division 1, Design, of the latest edition of the AASHTO Standard Specifications for Highway Bridges and any applicable Interim Specifications thereto, designated on the design drawings and to these specifications.

504.05 Facilities for Inspection. The Contractor shall furnish facilities for the inspection of materials and workmanship in the shop and the Inspectors shall be allowed free access to the necessary parts of the works.

The Contractor shall furnish a private office at the fabrication plant for inspection personnel authorized by the Department of Transportation.

The office shall have an area not less than 9.3 m² [100 square feet] and shall be conveniently located to the work. The office shall be heated, lighted and have the exit(s) closed by a door(s) equipped with a lock(s) and 2 keys which shall be furnished to the Inspector(s). The office shall be equipped with a desk or table having a minimum size of 1200 by 760 mm [4 by 2.5 feet], 2 chairs, a telephone, a plan rack and a 2-drawer, minimum, letter size file cabinet with a lock and 2 keys which shall be furnished to the Inspector(s).

The facilities and all furnishings shall remain the property of the Contractor upon completion of the work. Payment for the facilities, its heating and lighting, telephone installation, basic monthly telephone charges and all furnishings shall be incidental to the contract.

504.06 Inspector's Authority. The Inspector will have the authority to reject any material or work which does not meet the requirements of these specifications. The acceptance of any material or finished members by the Inspector will not preclude their subsequent rejection, if found defective at a later date.

504.07 Rejections. Rejected material and workmanship shall be replaced or corrected by the Contractor.

FABRICATION AND DELIVERY

504.08 Shop Certification. All bridge structures incorporating trusses, welded plate girders or curved members shall be fabricated in a fabrication shop holding a current certification by the American Institute of Steel construction, Inc. (AISC) in Category III.

If any of the members or parts of members to be fabricated are designated as fracture critical, the fabrication shop shall be AISC certified for fracture critical fabrication.

All structural steel other than that designated in the preceding paragraph, as well as all bridge bearings other than those specified in the following paragraph, sign bridges, cantilever and butterfly sign supports, high mast poles, modular expansion devices, and built-up structural members for repair or retrofit of trusses or welded beam spans shall be fabricated in a fabrication shop holding a current certification by AISC in Category I, II, or III.

Structural steel for simple span, rolled beam bridges up to 18 m [60 feet] span, steel parts for repair/retrofitting of existing structures up to and including rolled beam members 18 m [60 feet] in length and excluding built-up structural members included in the preceding paragraph, welded steel bridge bearings (sliding plate, rocker and fixed), deck drains, non-modular expansion devices, H-beam sign supports, and similar items shall be fabricated in a fabrication shop certified either by the Department or by AISC, at the shop's option.

Suppliers of rolled shapes and plates, such as rolling mills, steel warehouses, and steel service centers, who supply materials for subsequent incorporation by others into finished structures, need not be certified.

The Maine Department of Transportation certification will be based on inspection by the Department for adequacy of personnel, shop detail drawings, shop practices, welding procedures, shop equipment, materials control, familiarity with applicable codes and specifications, and such other items as may be of importance to the items being fabricated, and the Department reserves the right to limit its certification to specific fabricated items listed above depending on the evaluation of the facilities to be certified.

The Department may conduct unannounced reinspections of fabrication shops certified by the Department. Unless revoked by the Department on the basis of its reinspections, the Maine Department of Transportation certification shall be valid for a period of three years. If a fabrication shop's certification is revoked by the Department, and the shop corrects the conditions leading to revocation within the 30 calendar days following the effective date of the revocation of certification, the original certification will be restored. If the deficiencies are not corrected in the 30 day grace period, a new application for certification will be required.

Applications for certification or recertification shall be addressed to the Construction Division of the Maine Department of Transportation, attention of the Fabrication Engineer. A non-refundable fee of 500 dollars will be charged for each application for certification or recertification processed by the Maine Department of Transportation, which fee will cover the original inspection for certification and any reinspections during the effective period of certification. The Department will require up to sixty (60) days from the date of receipt of an application with fee, to inspect the facilities to be certified, interview its personnel, evaluate the data and issue its decision. Shops that are denied certification or recertification will be notified of the reasons for the denial. If the noted shortcomings are corrected within 30 calendar days of the

notice of denial, the shop in question may notify the Fabrication Engineer of that fact. If the Department finds the corrections satisfactory, registration may then be granted under the original application. Following this 30 day grace period, a new application for certification and fee will be required.

All material fabricated in an uncertified fabrication shop will be rejected.

504.09 Notice of Beginning Work. The Contractor shall give the Engineer ample notice of the beginning of work in the shop, so that inspection may be provided. No work shall be done in the shop before the Engineer has been so notified.

504.10 Mill Orders. When requested by the Engineer the Contractor shall furnish the Engineer with two copies of the mill orders.

504.11 Mill Tests. The Contractor shall furnish the Engineer, without charge, certified copies of the mill tests of all structural steel supplied. In addition to the results of chemical and physical tests, these test reports shall show the heat numbers, name of the manufacturer and the name of the testing laboratory or other concern making the test if other than the producer.

504.12 Storage of Materials Prior to Fabrication. Plain, as rolled, structural material shall be stored above the ground on platforms, skids or other supports. It shall be kept free from dirt, grease and other foreign matter, and, as far as practicable, shall be protected from corrosion.

504.13 Material Identification and Control. Structural steel plates and shapes shall be marked as specified in AASHTO M160/M160M (ASTM A6/A6M), Section 12, except as specified under Subsection 504.14. Upon delivery of structural steel plates and/or shapes to the fabrication shop the Engineer will verify mill test reports and heat numbers for conformance with the specifications and no material shall be used in the fabrication unless it is so verified. Any plates and/or shapes that are to be cut shall have the heat number transferred to all pieces, other than scraps, including those to be stored for future use on the same project or on future bridge projects. Failure to comply with this specification may be cause for rejection of the material.

504.14 Die Stamping. In the fabrication shop, no die stamping shall be used for any purpose on rolled shapes or plates to be used as main stress carrying members. Identification marks, either required by these specifications or by the shop, shall be stenciled or painted.

Any marking to be done at the mill, as required by AASHTO M160/M160M (ASTM A6/A6M), shall be done in no more than one place on each piece and die stamping, using low-stress blunt-nosed continuous or low-stress blunt-nosed interrupted dot steel dies, may be used.

504.15 Correcting Materials. Materials requiring correction for straightness, before being incorporated in a fabricated unit, may be corrected by any method that will not injure the metal, subject to the approval of the Engineer. If heating of the material is required it shall be done in accordance with a procedure submitted to and approved by the Engineer prior to the corrective

work being done and shall be in conformance with the requirements of Subsection 504.25, Heat-Curving and Cambering.

For general use a fabrication shop may submit a procedure for the correction of improper camber or sweep by heat for prequalification by the Engineer. However, corrective procedures shall not be applied to any structural member without the prior approval of the Engineer.

Following the corrective work, the metal shall be carefully inspected, using methods acceptable to the Engineer. The presence of cracks or fractures shall be cause for rejection of the material.

504.16 Flame Cutting. Structural steel permitted by these specifications may be flame cut, provided an accurate profile is secured by the use of a mechanical guide. Manually guided cutting shall be done only where approved by the Engineer.

Flame cut plates shall be prepared subject to the provisions of AASHTO M160/M160M (ASTM A6/A6M) and of Section 3.2, Preparation of Base Metal, of AASHTO/AWS D1.5, as amended by the Maine Department of Transportation. Repairs requiring welding shall not be made without the prior approval of the Engineer, and no welded repairs will be authorized for Type Y edge defects, or surface defects on flange plates, or flange coverplates subject to tension or stress reversal. It shall be the fabricating shop's responsibility to identify plates subject to tension or stress reversal on orders placed with plate suppliers. Flame cut edges of members carrying calculated stress shall have their corners rounded to a minimum radius of 2 mm [1/16 inch] by a process approved by the Engineer.

Flame cut edges of main material (cover plates, web plates, flange plates and splice material) of all steel other than AASHTO M183/M183M (ASTM A36/A36M), shall have an average hardness not exceeding Rockwell C30, and no individual point in a series of measurements shall exceed Rockwell C35. Hardness shall be measured at approximately mid-thickness of a plate edge and the spacing between individual measurements shall be as directed by the Engineer.

Hardness exceeding the above, on quenched and tempered steel, shall be removed by grinding or machining. On all other steel, areas of excess hardness may be removed by the application of heat or by grinding or machining. If a heating process is proposed for use, it shall be submitted to the Engineer for approval.

All hardness testing and necessary corrective action shall be done under the direct supervision of the Engineer and shall be done at no cost to the Department.

Slotted holes in masonry plates, rocker plates and sole plates of bearings may be flame cut using a mechanically guided cutting process. The use of a manually guided process will not be allowed. The finished holes shall meet the roughness requirements of paragraph 3.2.2 of

AASHTO/AWS D1.5. The location and dimensions of slotted holes shall be accurate to plus or minus 2 mm [1/16 inch].

504.17 Bent Plates. Cold-bent, 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.
- (b) The radius of bends shall be such that no cracking of the plate occurs. Generally accepted minimum radii, measured to the concave face of the metal, are shown in the following table in which "T" is the thickness of the plate:

METRIC

AASHTO (ASTM)	Thickness in Millimeters		
	Up to 12	Over 12 to 25	Over 25 to 50
M270M (A709M) Grade 250			
M270M (A709M) Grade 345	2 T	2 1/2 T	3 T
<u>M270M (A709M) Grade 345W</u>			

ENGLISH

AASHTO (ASTM)	Thickness in inches		
	Up to 1/2	Over 1/2 to 1	Over 1 to 2
M270 (A709) Grade 36			
M270(A709) Grade 50	2 T	2 1/2 T	3 T
<u>M270 (A709) Grade 50W</u>			

- (c) If a shorter radius is essential, the plates shall be bent hot at a temperature not greater than 620 °C [1150 °F]. Hot bent plates shall conform to the requirements of (a) above. Before bending, the edges of the plates shall be rounded to a radius of 2 mm [1/16 inch] throughout that portion of the plate where the bending is to occur.

504.18 Plates for Fabricated Members. Steel plates for flange cover plates, flange plates and splice plates may be furnished with flame-cut edges. Universal Mill edge plates may be furnished as acceptable alternates. Steel plates for web plates shall be flame-cut, in the fabrication shop, to produce the desired camber.

All plates, flame-cut from larger plates, shall be cut so that the primary direction of rolling is parallel to the main tensile or compressive stress.

Ends of flange plates which are to be butt-welded shall be scanned for laminations by ultrasonic straight beam scanning on a 75 mm [3 inch] grid. A distance of 300 mm [12 inches] from the specified ends shall be so scanned. Acceptance and repairs shall be based on the requirements of ANSI/AASHTO/AWS D1.5 Subsection 3.2.3, as amended by the requirements of paragraph 504.16 of these specifications.

504.19 Edge Planing. Sheared edges of plates more than 16 mm [inch] in thickness for use as flanges of welded beams, cover plates and bearing stiffeners shall be planed to a depth of 6 mm [$\frac{1}{4}$ inch]. Re-entrant cuts shall be filleted to a radius of not less than 20 mm [$\frac{3}{4}$ inch] before cutting.

504.20 Welding. All welding, both in the shop and in the field, shall be done in accordance with the requirements of the latest edition of ANSI/AWS D1.1, Structural Welding Code or ANSI/AASHTO/AWS D1.5, Bridge Welding Code as hereinafter specified.

504.201 Applicable Specifications. All single pass fillet welds, all butt-welds, T-welds and corner welds requiring a single pass per side, all non-structural welds, whether single pass or multiple pass (e.g. bridge drains, welds on expansion devices other than modular joints, etc), and welds on foundation piles shall be qualified and welded in accordance with the requirements of Sections 2, 3, 4 and 5 of either ANSI/AWS D1.1 or ANSI/AASHTO/AWS D1.5 at the Contractor's option.

All multiple pass welds for structural use, including multiple pass fillet welds, butt welds, T-welds, and corner welds, other than as specified above, shall be qualified and welded in accordance with the requirements of sections 2, 3, 4 and 5 of ANSI/AASHTO/AWS D1.5.

When welding using the requirements of ANSI/AWS D1.1, filler metals shall meet the requirements of Table 4.1 or 4.2 of ANSI/AASHTO/AWS D1.5 as applicable. E6010 or E6011 electrodes may be used for non-structural weldments or if specified on the plans.

Base metal for use in welded construction shall conform to the requirements of Subsection 713.01 of the Standard Specifications.

The term "Contractor" as used herein signifies the party responsible for performing the work as required by the contract documents, and is used collectively to mean contractor, manufacturer, fabricator or erector.

504.202 Welding Processes. Flange plate and web plate butt joints, web to flange welds, bearing stiffener to web welds, and cover plate to flange welds shall be made using the automatic submerged arc welding, automatic gas shielded metal arc welding, or automatic flux-cored arc welding process. Semi-automatic submerged arc welding, semi-automatic gas shielded metal arc welding, or flux-cored arc welding shall be used for the above welds only with prior approval of the Engineer.

All other welds, whether made in the field or the fabrication shop, may be made by any process approved by either of the codes specified under Subsection 504.20. However, the use of Electroslag and Electrogas welding will not be allowed for any welds in tension and stress-reversal areas, and may be used for welds in compression areas only with the written approval of the Engineer and under the conditions specified by the Engineer.

Repairs to welds shall be made using the same process as was used for the original welds, except that repairs less than 300 mm [12 inches] in length, in welds made using automatic or semi-automatic processes, may be made by manual shielded metal-arc welding using an approved welding procedure.

504.203 Welding Procedures. All joint welding procedures to be used shall be prepared by the Contractor as a written procedure specification and shall be submitted for the Engineer's approval as part of the shop drawings.

All welding procedures for use in the fabrication or repair of structural members shall be qualified by tests in accordance with the requirements of the applicable code specified under 504.201, except that welds made with the shielded metal arc welding process (SMAW), using electrodes producing weld metal with a yield strength less than 620 MPa [90 ksi] will be considered prequalified and need not be tested. All tests shall be done under the direct supervision of the Engineer.

Welding procedure qualification tests conducted for other states or other agencies and meeting the requirements of the applicable code in all respects may be used to satisfy the requirements of the previous paragraph, subject to approval by the Engineer.

Each Contractor shall conduct all tests required to qualify joint welding procedures. Any costs incurred by the Contractor in conducting said tests shall be considered incidental to the related contract items.

At each welding station a copy of the appropriate Welding Procedure Specification (WPS) for the weld configuration being welded and the welding process being used at that station shall be available for the welder's or welding operator's use. Only copies of WPS's bearing the approval stamp of the Maine Department of Transportation shall be used.

504.204 Welders. Fabricating shops shall prequalify welders, welding operators and tackers in accordance with these Specifications. If the Contractor certifies to the Engineer that a welder, welding operator or tacker has been prequalified previous to the beginning of work on the subject structure, the Engineer may consider him/her qualified. Such a certification of prequalification may also be accepted as proof that a welder, welding operator and tacker is qualified for field welding, if a Contractor who submits it is properly staffed and equipped to conduct such an examination or if the examining and testing is done by a recognized agency which is staffed and equipped for such purpose. Any costs incurred by the Contractor in qualifying welders, welding operators or tackers shall be considered incidental to the respective contract items. As an

alternate, valid certification of welders, welding operators and tack welders by the American Welding Society for the appropriate weld configuration (groove or fillet), welding process, and welding position will also be acceptable.

504.205 Welded Fabrication. Edges of built-up beam and girder webs shall be cut to the prescribed camber, with suitable allowance for shrinkage due to cutting and welding. If the Engineer so directs, variations from the specified camber may be corrected in conformance with the applicable provisions of Article 504.15, Correcting Materials, of the Standard Specifications Highways and Bridges.

Mill scale shall be removed from the surfaces on which flange-to-web, coverplate-to-flange, or bearing stiffener-to-web welds are to be made using the submerged arc welding (SAW), flux-cored arc welding (FCAW), or gas-metal arc welding (GMAW) process.

Tack welds which are incorporated into a final weld shall be made with electrodes meeting the requirements of the final weld, shall be sized so that they are completely remelted during the making of the final weld, and shall be cleaned thoroughly.

Welds shall be started and terminated at the ends of joints in a manner that will insure sound welds. This shall be done by the use of extension bars or runoff plates.

All web and flange plate butt joints shall be welded, ground flush, tested and approved, before the plates are fitted and welded into girders.

Temporary welds and tack welds not incorporated in a final weld, in locations more than one-sixth of the depth of the web from either flange of a beam or a girder, may be used without prior approval by the Engineer. Temporary welds in other locations shall be made only with prior approval by the Engineer, shall be shown on the shop detail drawings and shall be made with an approved low hydrogen welding procedure. All temporary welds shall be subject to the same welding procedure requirements as final welds. They shall be removed unless otherwise permitted by the Engineer. When they are removed, the surface shall be made flush with the original surface.

When welds are to be galvanized, the weld metal analysis of the electrode used shall not exceed 0.40 percent silicon.

504.206 Inspection. For the purpose of this specification, quality control and quality assurance are separate functions, except as herein specified.

Quality Control (Q.C.) is the responsibility of the Contractor. He shall inspect all aspects of his work and shall perform testing to not less than the extent specified in this section, after notifying the Quality Assurance Inspector at least 24 hours in advance to facilitate his attendance. The Contractor may do non-destructive testing in addition to the minimum specified in this

section, as he deems necessary. The results of any testing shall be made available to the Q.A. Inspector.

Quality Assurance (Q.A.) is the prerogative of the Engineer. He will inspect all aspects of the work and will witness and direct all specified testing, done by the Contractor, in order to assure an acceptable product in accordance with the contract documents. Any Q.A. testing deemed necessary by the Engineer in addition to the testing specified to be done by the Contractor, will be scheduled in consultation with the Contractor, in order to minimize interference with the production schedule.

Flange plate and web plate butt-joints, web to flange welds, bearing stiffener to web welds, cover plate to flange welds, welds on bearings, and any welds other than above specified, that are subject to calculated stresses shall be inspected and tested to the requirements of Section 6, Inspection, of ANSI/AASHTO/AWS D1.5 - Bridge Welding Code. All costs to the Contractor for the specified testing will be considered incidental to the related contract item.

The Contractor shall notify the Engineer at least five working days in advance of the start of the fabrication/erection operations subject to inspection and verification, shall keep the Q.A. inspector advised of the production schedule and shall advise the Q.A. inspector of any changes made to it. If the Contractor suspends production on a project, the Engineer may, at his/her option, require 48 hours notice prior to resumption of the production.

The Q.A. Inspector shall base his/her acceptance/rejection of any material, weld or fabricated unit on the applicable sections of the contract documents and on a complete set of shop detail drawings, stamped by the Engineer and showing, among others, the size, length, type, location and welding procedure number for all welds to be made.

504.207 Applicability. The provisions of Subsection 504.20 shall be construed as being supplementary to the referenced codes.

In case of conflict between the provisions of this specification and the referenced codes the provisions of this specification shall govern.

504.21 Prequalified Welders. The fabrication shop shall maintain a file of certificates of prequalification for its welders and welding operators and make the file available to the Engineer upon request. Each certificate of qualification shall state the name of the welder or welding operator, the name and title of the person who conducted the examination, the kind of specimens, the position of welds, the results of the tests and the date of the examination.

For each project the fabrication shop shall submit a letter of compliance to the Engineer, listing by name all welders and welding operators to be employed on the fabrication of structural steel for the project. The letter shall certify that these welders or welding operators have been prequalified and that they have been continuously engaged in metal-arc welding, with no lapses in such employment in excess of six months, since being prequalified. For large projects the

fabrication shop may be required to submit interim lists for portions of the work, at the request of the Engineer.

504.22 Camber. If camber is required for beams or girders, the camber will be so specified on the plans and for more complicated designs, such as continuous beams or girders, a camber diagram will be a part of the plans. Provision shall be made by the fabricator to compensate for changes in the camber, resulting from the welding of structural members, when such welding is required.

504.23 Holes for High Strength Bolts. Holes for high strength bolts shall be subpunched or subdrilled 5mm [3/16 inch] smaller and after assembling, shall be reamed to 2 mm [1/16 inch] larger or shall be drilled from the solid to 2 mm [1/16 inch] larger than the nominal diameter of the bolts except as follows. Holes for high strength bolts in material for X-frames or diaphragms and their associated end connections may be punched 2 mm [1/16 inch] larger than the nominal bolt diameter whenever the thickness of the metal is not greater than 20 mm [¾ inch] for AASHTO M183/M183M (ASTM A36/A36M) steel, 16 mm [inch] for AASHTO M222/M222M (ASTM A588/A588M) and AASHTO M223/M223M (ASTM A572/A572M) steel or 12 mm [½ inch] for AASHTO M244/M244M (ASTM A514/A514M) and ASTM A517/A517M steel. When any material is thicker than the foregoing limits, punching will not be allowed and holes shall be subdrilled and reamed or drilled full size.

For any connection the fabricator may, at his option, subpunch and ream, subdrill and ream or drill holes full size with all thicknesses of the material assembled in proper position or drill holes full size in each individual piece of a connection separately, provided that the requirements of Subsection 504.24 are met by the fully assembled connection.

For punched holes the diameter of the die shall not exceed the diameter of the punch by more than 2 mm [1/16 inch]. Holes must be clean cut, without torn or ragged edges.

Reamed or drilled holes shall be cylindrical and perpendicular to the member. Where practicable, reamers shall be directed by mechanical means. Burrs caused by drilling or reaming shall be removed from all parts.

Oversize or short-slotted holes may be used in all connections other than splices of main load carrying members and end connections of floor beams. The size and application of oversize and short-slotted holes shall be governed by the requirements of Subsection 504.04.

504.24 Accuracy of Holes. After assembling all parts of a connection containing subpunched or subdrilled holes, and before any reaming is done, it shall be possible to enter a pin 3 mm [1/8 inch] smaller in diameter than the nominal size of the subpunched or subdrilled hole in at least 75 percent of the contiguous holes in the same plate. Additionally, when assembled, all holes in a connection shall be able to pass a pin 5 mm [3/16 inch] smaller in diameter than the nominal size of the subpunched or subdrilled holes. Pins shall be entered perpendicular to the

face of the member and no drifting will be allowed. Failure to comply with either of the above criteria will be cause for rejection.

If holes are punched full size, all holes in a connection shall be able to pass a pin 2 mm [1/16 inch] smaller in diameter than the nominal size of the holes with all plies of the connection in their proper relationship for assembly.

Following the completion of the drilling or reaming of all holes in any contiguous group and with all plies of a connection in their proper relationship for assembly, no hole shall show an offset greater than 1 mm [1/32 inch] between adjacent thicknesses of metal.

No finished hole shall be located more than 3 mm [1/8 inch] laterally from its theoretical location. Repair of mislocated holes shall be subject to the approval of the Engineer.

504.25 Heat-Curving and Cambering. Structural members designed to be curved horizontally and/or cambered may be brought to the desired curvature and/or camber by the application of controlled heat, using a procedure approved by the Engineer. This procedure may also be used on straight members for the correction of over or under-cambering and excessive sweep.

Steel manufactured to a specified minimum yield strength greater than 345 MPa [50,000 psi] shall not be heat-curved or cambered.

The approved procedure shall specify the following:

1. The proposed heating pattern, showing location and distribution of heated areas, size and shape of heated areas and sequence of heating.
2. Method of support of the member.
3. Temperature proposed to be used.
4. Method of heating (Gas, gas flow, nozzle size, etc.).
5. Method and rate of cooling.

Heat-cambering of rolled beams and the correction of over or under-camber in both rolled or welded beams shall be done only by the application of Deep-V heating. The height of the heated area shall be at least 3/4 of the member depth, and shall have an included angle of 10-15 degrees, with a width at the base of 200-250 mm [8-10 inches], except that for rolled beams with a nominal depth of 690 mm [27 inches] or less blockheats may be used on the appropriate flange.

Curving of rolled beams and welded beams or the correction of excessive sweep shall be done by the simultaneous application of heat to truncated triangular areas on both flanges. The heated areas shall have an included angle of 15-30 degrees, a height not to exceed 65 percent of the flange width, and a width at the base of not over 250 mm [10 inches]. For flanges with a thickness over 25 mm [1 inch], both the outside and inside surfaces of the flanges shall be heated concurrently, except that the heating of the inside pattern shall begin at a point 15 mm [1/2 inch]

clear of the flange to web fillet or fillet weld. Flanges 300 mm [12 inches] or less in width may be heat-curved by the application of heat to a continuous strip along the appropriate edge of the 300 mm [12 inch] wide flanges. When coverplates are to be attached to rolled beams, they may be attached before heat-curving, provided the total thickness of the flange plus coverplate is not more than 64 mm [2½ inches] and the radius of curvature is 300 m [1000 feet] or more. For all other rolled beams with coverplates, the coverplates shall be individually heat-curved or oxygen-cut to the required radius before attaching to the curved beam. All stiffeners and connection plates shall be installed after the heat-curving is complete.

The temperature used for heat-cambering or heat-curving shall be between 425 °C and 540 °C [800 °F and 1000 °F] as measured with temperature indicating crayons or other suitable means supplied by the Contractor. Steel heated above 620 °C [1150 °F] will be rejected. The use of cutting or gouging tips for heating purposes will not be allowed.

Following the application of heat, the metal shall be allowed to cool in still air to below 315 °C [600 °F], after which artificial cooling may be used. The direct application of water will not be allowed at any time.

After heat-cambering, heat-curving, or the correction of camber or sweep by heat, the welded structural members shall meet the dimensional requirements of ANSI/AASHTO/AWS D1.5, paragraph 3.5.1, and rolled beams shall meet the dimensional requirements of paragraph 3.5.1.4 of the above AWS D1.5 and Subsection 504.31, Tolerances, of the standard specifications.

All procedures under this subsection shall be carried out in the presence of the Engineer and any heating process applied to a structural member without the Engineer being present shall be cause for the rejection of that member.

504.26 Shop Assembling. Abutting members at field splices of continuous beams and girders, rigid frames and bents shall be placed in the exact relative field position for erection and shall be assembled with their associated splice material and shall be checked for conformance with the requirements of Subsection 504.24. Joint openings shall conform to the requirements of Subsection 504.30. All material shall be match marked before being disassembled.

Bearing assemblies shall be shop assembled and the individual pieces match marked or they shall be shop assembled and shipped as a unit.

504.27 Match marking. Connecting parts assembled in the shop for the purpose of reaming or drilling holes in field connections shall be match marked and a diagram showing such marks shall be furnished to the Engineer.

504.28 Connections Using High Strength Bolts. This subsection covers the assembly of structural joints using AASHTO M164M (ASTM A325M) [AASHTO M164 (ASTM A325)] high strength carbon steel bolts tightened to a high tension. The bolts are used in holes

conforming to the requirements of Subsection 504.24. Direct Tension Indicators (DTI's) may be used (at the Contractor's option) as a means of controlling bolt tension in friction type connections. Use of DTI's is subject to the applicable provisions of Subsections 504.28 and 713.02.

- (a) Bolts, Nuts, Washers and Direct Tension Indicators. All bolts, nuts, washers, and Direct Tension Indicators (DTI's) shall conform to the requirements of Subsection 713.02.

All bolts and the associated nuts, washers, and DTI's for a project shall be furnished by one supplier and shall preferably be from one manufacturer. Should it prove to be impractical to obtain all bolts, nuts, washers and DTI's for a project from a single source, the Contractor shall submit a work plan for the Engineer's approval that will ensure that all bolts, nuts, washers and DTI's in each individual main structural connection or group of such connections (i.e. beam and girder splices, floor beam end connections, truss members end connections, etc.) will be from a single source.

- (b) Test Specimens. From each lot or batch in a shipment the Engineer may, at random, select three specimens of each length and diameter bolt in such lot or batch, along with the associated nuts, washers, and DTI's for testing by the Department. The cost of the selected specimens will be considered incidental to the appropriate contract items.
- (c) Bolted Parts. Surfaces of bolted parts in contact with the bolt head and nut shall not have a slope more than 1 to 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, washers, and DTI's shall be free of mill scale, dirt, burrs, or other defects that would prevent solid seating of the parts.

Joints will be of the friction type unless otherwise specified. Contact surfaces within friction type joints shall be free of oil, paint, lacquer, galvanizing or other coating, unless otherwise specified.

- (d) Installation. Bolts shall be installed with a hardened washer under the nut or bolt head, whichever is the element turned in tightening, except that bolts in oversized or short-slotted holes shall have a washer under both the head and the nut. A flat washer may be used when the abutting surface adjacent to the bolt head or nut has a slope of not more than 1 to 20 with respect to a plane normal to the bolt axis. Where an outer face of the bolted parts has a slope of more than

1 to 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.

When DTI's are not used all fasteners in a connection shall be tightened to have between 105 and 110 percent of the required minimum bolt tension values shown in Table 1A of this subsection, when the joint has been completed. Tightening shall be done with properly calibrated wrenches or by the turn-of-nut method. If required because of bolt entering and/or wrench operation clearances, tightening by either procedure may be done by turning the bolt while the nut is prevented from rotating. 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.

When DTI's are used, they shall be installed in accordance with manufacturer's installation instructions, except that DTI's shall at all times be installed under the stationary part of the bolt-nutwasher assembly. Installation of DTI's under the rotating part of the bolt-nut-washer assembly shall be done only with the prior approval of the Engineer.

METRIC UNITS
TABLE 1 -- BOLT TENSION

Bolt Diameter		: Required Minimum
Millimeters		: Bolt Tension ¹ (kN)
M16	:	94.2
M20	:	147
M22	:	182
M24	:	212
M27	:	275
M30	:	337
<u>M36</u>	:	<u>490</u>

¹Equal to the proof load of bolt in AASHTO M164M (ASTM A325M).

ENGLISH UNITS
TABLE 1 -- BOLT TENSION

Bolt Diameter (Inches)	:	Required Minimum Bolt Tension ¹ (pounds)
1/2	:	12,050
5/8	:	19,200
3/4	:	28,400
7/8	:	39,250
1	:	51,500
1 1/8	:	56,450
1 1/4	:	74,000
1 3/8	:	91,250
1 1/2	:	110,400

¹Equal to the proof load of bolt in AASHTO M164 (ASTM A325).

METRIC UNITS
TABLE 1A -- DTI GAP REQUIREMENTS

Direct Tension Indicator Size (bolt With diameter, mm)	:	Number of Protrusions: (equally spaced)	:	Closed Gaps
	:		:	
M16	:	4	:	2
M20	:	5	:	3
M22	:	5	:	3
M24	:	5	:	3
M27	:	6	:	4
M30	:	7	:	4
M36	:	8	:	4

ENGLISH UNITS
TABLE 1A -- DTI GAP REQUIREMENTS

Bolt Diameter (Inches)	: DTI :Protrusions	: Closed : Gaps
1/2	: 4	: 2
5/8	: 4	: 2
3/4	: 5	: 3
7/8	: 5	: 3
1	: 6	: 3
1 1/8	: 6	: 3
1 1/4	: 7	: 4
1 3/8	: 7	:
1 1/2	: 8	: 4

Fasteners shall be protected from moisture and dirt at all times. Fasteners that have become rusted or dirty shall be cleaned and lubricated prior to installation.

- (e) Calibration. On projects involving main structural connections, a tension measuring device (Skidmore- Wilhelm calibrator or approved equal) which has been calibrated by an approved testing agency not more than 12 months prior to its use, shall be at the job site during steel erection for use in calibrating the installation procedures.

Standard torques determined by the use of tables or formulas that attempt to relate torque to tension will not be acceptable.

The installation procedures, whether "Calibrated Wrench" or "Turn of Nut", shall be calibrated at least once each working day for fastener assemblies of each diameter and length being installed, by tightening in the tension measuring device, in succession, three typical fastener assemblies (bolt, nut, and washer) for each diameter and length, and such calibration shall be done using the actual equipment and personnel used for fastener installation, and shall be witnessed by the Engineer. Bolts that are too short for calibration in the tension measuring device may be tightened in a steel joint, using direct tension indicating washers (DTI's). The DTI's shall first be calibrated in a tension measuring device using longer bolts.

The installation procedure shall produce a fastener tension not less than five percent nor more than 10 percent in excess of the Required Minimum Bolt Tension specified in Table 1.

When DTI's are used in bolted connections no calibration of the tightening procedure is required. The Contractor shall, however, prove by actual

demonstration that the personnel assigned the task of tightening the fastener assemblies has the skill to consistently produce fastened assemblies meeting the requirements of this specification.

- (f) Tightening. Fastener assemblies shall be installed in all holes of a connection and all shall be brought to a "Snug Tight" condition, progressing systematically from the most severely restrained location in a connection to its free edges. "Snug Tight" is defined as the tightness that exists when all the plies in a connection have been brought into firm contact throughout by the application of a few impacts by an impact wrench or by the full effort of a person using an ordinary spud wrench and represents the application of approximately ten percent of the Minimum Required Tension to all bolts. Connections using DTI's shall be brought to a "snug-tight" condition as above, except that, following snugging, the average gap on all DTI's in a connection shall not exceed 1 mm [0.040 inch], and no DTI's shall have an average gap less than 0.4 mm [0.015 inch]. Any DTI's having an average gap less than 0.4 mm [0.015 inch] following snugging of a connection shall be removed and the fastener assembly shall be resnugged using a new DTI.

Following this initial tightening, connections shall be tightened to their final condition using one of the three following methods:

1. Calibrated Wrench Tightening. Power wrenches shall be adjusted to stall or cutout at the selected calibrating 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 fastener assemblies of the tested lot. Nuts shall be in tightening motion when torque is measured. When using calibrated wrenches to install several fastener assemblies in a single joint, the wrench shall be returned to "touch up" fasteners previously tightened and which may have been loosened by the tightening of subsequent fasteners, until all are tightened to the prescribed amount. Fastener assemblies shall always be tightened by progressing systematically from the most severely restrained location in a connection (e.g. the center of web splice plates) to its free edges.
2. Turn-of-Nut Tightening. Following the initial tightening to a "Snug Tight" condition, the fastener assemblies in a connection may be brought to their final condition by applying the additional nut rotation specified in Table 2, starting at the most severely restrained location in a connection and systematically progressing outward to its free edges. There shall be no rotation of the stationary part of the fastener assembly while the moving part is being rotated.
3. Fastener Assemblies with DTI's. All fasteners in connections using DTI's shall be tightened to the extent that a 0.4 mm [0.015 inch] feeler gauge is

refused in not less than the number of spaces listed in Table 1A and a 0.1 mm [0.003 inch] feeler gauge can be inserted in at least one space.

- (g) Inspection. Before the installation of fastener assemblies in the work is begun, the Engineer will check the marking, surface condition, storage and handling, and the required test results of bolts, nuts, washers, and DTI's, and the condition of the fraying surfaces of connections for compliance with the requirements specified under this Subsection and Subsections 504.38 and 713.02. He will observe the calibration and/or testing procedures specified herein to confirm that the selected procedure is properly used and that, when used with the fastener assemblies provided, the tensions specified in Subsection "d" are attained as a minimum. The installation of fasteners in the work will be monitored by the Engineer to verify that the selected procedure, which demonstrated its ability to attain the specified tension during the initial calibration, is routinely being used in a proper manner.

Additionally, the Engineer will witness the Rotational Capacity Test as described in Subsection 713.02, using two randomly selected fastener assemblies from each shipping lot. When DTI's are used as part of the fastener assemblies, the Engineer will additionally witness a DTI verification test for each position of the DTI with respect to the turned element in each rotational capacity lot. Each DTI verification test shall be as described in Subsection 713.02, and shall use three randomly selected fastener assemblies.

For joints not using DTI's, inspection of all completed joints is required and shall be done within 72 hours following completion of each joint. The following inspection procedure shall be used unless a different procedure is specified in the contract documents.

1. Either the Engineer or the Contractor in the presence of the Engineer, at the Engineer's option, shall use a torque wrench as an inspection wrench.
2. At least once each day, a representative sample of five bolts from the diameter, length and grade of the bolts used in the work shall be tightened in the tension measuring device by any convenient means, to an initial condition equal to approximately 10 percent of the required fastener tension and then to the minimum tension specified in Subsection "d". There shall be a washer under the part turned in tightening each bolt. Tightening to the required minimum tension must not produce greater nut rotation than 1½ times that specified in Table 2. The job inspecting torque shall be taken as the average of three values thus determined, after rejecting the high and low values.
3. Bolts represented by the sample in the preceding paragraph which have been tightened in the structure shall be inspected by applying, in the

tightening direction, the inspecting wrench and the job inspecting torque to 10 percent of the bolts, but not less than two bolts, selected at random in each connection in question. If no nut or bolt head is turned by the application of the job inspecting torque, the connection shall be accepted as properly tightened. If any nut or bolt is turned more than five degrees (approximately one inch at a twelve inch radius) by the application of the job inspecting torque, all bolts in the connection shall be tested, and all bolts whose nut or head is turned more than the specified five degrees by the job inspecting torque shall be retightened and reinspected. Alternatively, the fabricator or erector, at his option, may retighten all of the bolts in the connection for the specified reinspection.

TABLE 2
Nut Rotation¹ from Snug Tight Condition

Disposition of Outer Faces of Bolted Parts			
Bolt length measured from underside of head to extreme of point	Both faces normal to bolt axis ³	One face normal to bolt axis and other face sloped not more than 1 to 20 (bevel washer not used) ³	Both faces sloped not more than 1 to 20 from normal to axis (bevel washer not used)
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diam. but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 diam. but not exceeding 12 diameters ²	2/3 turn	5/6 turn	1 turn

¹Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance shall be plus or minus 30 degrees; for bolts installed by 2/3 turn and more, the tolerance shall be plus or minus 45 degrees.

²No research work has been performed by the Research Council on Riveted and Bolted Structural Joints to establish the turn-of-nut procedure when bolt lengths exceed 12 diameters. Therefore, the required rotation must be determined by actual tests in a suitable tension measuring device simulating the actual condition.

³The tolerances in footnote 1 may be exceeded if calibration in an approved tension measuring device shows that the specified minimum tension can not be obtained or is exceeded when using the specified turns.

For joints using DTI's, inspection will consist of verifying that the installation of the fastener assemblies conforms to the installation of the fastener assemblies as tested in the DTI verification test(s), that a 0.4 mm [0.015 inch] feeler gauge is refused in not less than the number of spaces

listed in Table 1A, and that a 0.1 mm [0.003 inch] feeler gauge can be inserted in at least one space of the DTI.

Unless otherwise specified, the Contractor shall provide all necessary torque or power wrenches, all calibration equipment, all feeler gauges and all labor required to perform the above testing. A Technical Representative from the DTI Manufacturer shall be present during initial testing and installation of DTI's. Each torque wrench shall have a maximum capacity that is at least 100 percent higher than the desired torque application. All wrenches shall be equipped with a dial face gauge with a pointer, and for positive verification of the actual torque applied, it shall be equipped with a memory pointer that remains at the applied torque reading after the tension has been released. All wrenches shall be graduated in increments not to exceed two percent of the maximum capacity of the wrench and shall be readable to, and accurate to, one percent of the maximum capacity. Each wrench shall be accompanied with the necessary sockets, extension handles, and other related equipment and shall be acceptable to the Engineer. No separate payments will be made for said testing. Any cost will be considered incidental to the bid items.

504.29 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 American Standards Institute surface roughness requirements as defined in ANSI B46.1, Surface Roughness, Waviness and Lay, Part 1 as follows:

Steel Slab	50 µm [2000 micro inch]	
Heavy plates in contact in shoes to be Welded		25 µm [1000 micro inch]
Milled ends of compression members, stiffeners & fillers		15 µm [500 micro inch]
Bridge rollers and rockers	10 µm [250 micro inch]	
Pins and pin holes	5 µm [125 micro inch]	
Sliding bearings	5 µm [125 micro inch]	

The above finishes are maximum roughness values and shall preferably be 10 percent less. Acceptability of a finished surface may be established by comparison of that surface with Roughness Comparison Specimens.

Additionally, mating surfaces shall be in contact over not less than 90 percent of the contact area.

When ordering material that is to be machined, an allowance for machining shall be included in the ordered dimension such that the finished dimension shall not be less than the dimension given on the plans.

504.30 Abutting Joints. Abutting joints in compression members and where so specified on the drawings, in tension members, shall be faced and brought to an even bearing. Where joints are not faced, the opening shall be 6 mm [$\frac{1}{4}$ inch], with a tolerance of plus or minus 3 mm [inch].

504.31 Tolerances. Finished members shall be true to line and free from twists or bends and shall be subject to the following tolerances unless otherwise specified.

When no camber or sweep is specified, variations in straightness of rolled beams, with and without cover plates, shall not exceed,

METRIC FORMULA

1 mm x total length of member in meters

ENGLISH FORMULA

inch x $\frac{\text{total length of member in feet}}{10}$

Variations from specified camber in rolled beams, with and without cover plates, shall not exceed the values given in Table 3.

METRIC UNITS
TABLE 3
CAMBER ORDINATE TOLERANCES
(Rolled Beams)

Lengths	Plus Tolerance	Minus Tolerance
15 m and Less	13 mm	0
Over 15 m	13 mm plus 1 mm/m in excess of 15 m	0

ENGLISH UNITS
TABLE 3
CAMBER ORDINATE TOLERANCES
(Rolled Beams)

Lengths	Plus Tolerance	Minus Tolerance
50 ft. and Less	½ inch	0
Over 50 ft.	½ inch plus inch for each 10 ft. or fraction thereof in excess of 50 ft.	0

Dimensional tolerances for welded beams and girders shall be as specified in the most recent edition of ANSI/AASHTO/AWS D1.5.

Any member having camber or sweep in excess of the above tolerances shall be corrected if so directed by the Engineer.

504.32 Fit of Stiffeners. Stiffeners shall be fitted as detailed on the Contract plans.

504.33 Vacant.

504.34 Screw Threads. Unless otherwise specified, threads for all pins and bolts for structural steel construction shall be the ISO standard coarse pitch M Profile Metric Screw Threads (ANSI B1.13M) and shall have Class 6g tolerances for pins and bolts and Class 6h tolerances for nuts, [Unified Screw Threads Series as specified in the American Standard for Unified Screw Threads (ANSI B1.1) and shall have Class 2A tolerances for pins and bolts and Class 2B tolerances for nuts] unless otherwise specified.

504.35 Bronze or Copper-Alloy Bearing and Expansion Plates. bronze or copper-alloy bearing and expansion plates shall be fabricated in accordance with the details as shown on the plans and the provisions of Subsection 713.04 and shall be self-lubricating.

The matching steel sliding surface or surfaces shall be shop coated with a lubricant compatible with the lubricating compound in the bearing or expansion plate. This lubricant shall be recommended and supplied by the manufacturer of the bearing or expansion plates.

504.36 Shop Coat. Unless specified otherwise, steel work specified to be painted shall be painted one coat, of shop coat paint, in conformance with Special Provision 506 -- Painting Structural Steel, after it has been accepted by the inspector, with the following modifications. All steel shall be blast cleaned to SSPC-SP10 after fabrication.

Masonry plates and bearing surfaces of expansion bearing rockers shall be painted two coats of shop paint.

Surfaces not in contact but inaccessible after assembly or erection shall be painted three coats of shop paint. Contact surfaces for friction type connections shall not be painted or coated in any way unless specified otherwise. If it is expected that there will be a prolonged period of exposure before the steel can be erected, the fabricator and/or contractor shall take such measures to prevent unacceptable corrosion of contact surfaces as the Engineer may direct or approve.

Surfaces which will be in contact with concrete shall not be painted unless specified otherwise. Structural steel which is to be welded shall not be painted before welding is complete. If it is to be welded only in the fabricating shop and subsequently erected by bolting, it shall be painted one coat of shop paint after shop welding is finished unless specified otherwise. Steel which is to be field welded shall be given one coat of boiled linseed oil or other approved coating after shop welding and shop fabrication is completed.

Machine finished surfaces with a roughness height of 5 m [125 micro-inches] or less shall be coated with a non- corrosive, waterproof, high pressure lubricant having a temperature range of -34 °C to 65 °C [-30 °F to 150 °F], National Lubrication and Grease Institute number not

lower than 2 and an OK load of not less than 9 kg [20 lbs] as measured by the requirements of ASTM D2509, except as follows. All sliding surfaces of self-lubricating bearings shall be coated with a lubricant recommended and supplied by the manufacturer of the self-lubricating plates. Metal surfaces designed for sliding contact with TFE coated bearing surfaces shall not be lubricated.

Material shall not be loaded for shipment until the paint is thoroughly dry and in any case not less than 24 hours after the paint has been applied.

504.37 Unpainted Steel. Structures fabricated of AASHTO M270/M270M (ASTM A709/A709M) Grade 345W [50W] steel are to remain in the bare unpainted condition, unless otherwise noted on the plans. All surfaces of all members of such structures shall be blast cleaned to remove mill scale. Blast Cleaning shall be done in accordance with the provisions of Steel Structures Painting Council's "Surface Preparation Specification SSPC-SP10 No. 6, Commercial Blast Cleaning", or equivalent. Slag, flux, spatter and discoloration shall be carefully removed from welded areas by power tool or blast cleaning. Acids shall not be used to remove scale or stains. Any miscellaneous steel work for use in conjunction with an unpainted structure, shall be cleaned as specified above and painted as specified on the contract plans.

504.38 Marking and Delivery. 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.

Erection marks for the field identification of members and weight marks, when required, shall be painted upon surface areas previously painted with the shop coat.

Erection marks, match marks and weight marks on AASHTO M270/M270M (ASTM A709/A709M) steel, intended for use in the unpainted condition, shall be placed where they will not be exposed in the finished structure.

The Contractor shall furnish the Engineer as many copies of material orders, shipping statements and erection diagrams as the Engineer may direct.

All bolts with the same length and diameter, along with the required number of nuts and washers for that length and diameter, shall be packed together in heavy duty plastic bags, in heavy duty waterproof containers. If the bolt and associated nuts and washers for a project are supplied by more than one supplier, all bolts, nuts and washers in a container shall be from the same supplier.

Each container shall have a list and description of the contained material, including the identifying shipping lot number and applicable Rotational-Capacity test results, in a waterproof envelope, firmly attached to the outside of the container.

Small parts, pins, etc., shall be packed in separate containers and shall not be packed in a common container with nuts and bolts.

504.39 Handling and Storing Materials. Fabricated materials, which are stored at the fabricating shop, at the project site or elsewhere, shall be placed upright on platforms, skids or other supports above the ground. They shall be kept clean and properly drained. Members shall be supported in a manner that will prevent injury due to excessive deflection or torsion.

On all members fabricated of AASHTO M222/M222M (ASTM A588/ A588M) steel and intended for use in the unpainted condition, contamination by grease, oil, paint or other foreign material shall be avoided, but if such contamination does occur, it shall be removed as soon as practical. In areas exposed to direct view only non-abrasive means may be used for such removal.

In handling fabricated members, care shall be exercised to prevent gouges, scratches and dents. Chains and wire rope slings shall not be used in immediate contact with fabricated members when such members are being lifted or transported.

Structural members shall be loaded on trucks or cars in such a manner that they may be transported to and unloaded at their destination without being excessively stressed, deformed or otherwise damaged.

ERECTION

504.40 General. 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 and will establish the lines and elevations required for placing the steel.

The Contractor shall erect the structural steel, erect and remove any falsework and do all work required to complete the structural steel for the bridge or bridges as covered by the agreement, all in accordance with the plans and these specifications.

504.41 Plans. If fabrication and erection of the superstructure are done under separate contracts, the Department will furnish detailed plans for the bridge or bridges to be erected, including shop details, camber diagrams, erection diagrams, list of field bolts and copies of shipping statements, showing a list of parts to the Contractor for the erection.

504.42 Plant. The Contractor shall provide the falsework and all tools, machinery and appliances, including drift pins and fitting-up bolts, necessary for the expeditious conduct of the work.

504.43 Delivery of Materials. If the contract is for erection only, the Contractor shall receive the materials entering into the finished structure, free of charges, at the place designated

and loaded or unloaded as specified. The Contractor shall unload promptly upon delivery any material delivered on railroad cars or barges which he is required to unload, otherwise he shall be responsible for any demurrage charges incurred. The Contractor shall check the material turned over to him against the shipping lists and report promptly in writing any shortage or damage discovered. He shall be responsible for the loss of any material while in his care and for any damage to it after being received by him. Storage of material shall comply with the requirements of Subsection 504.39.

504.44 Methods and Equipment. Before starting the work of erection, the Contractor shall inform the Engineer fully as to the method of erection he proposes to follow, and the amount and character of equipment he proposes to use, which shall be subject to the approval of the Engineer. The Contractor shall prepare and submit to the Engineer, for his approval, plans for any falsework and/or for modifications to an existing structure necessitated by construction loading. The falsework and/or modifications shall be properly designed and substantially constructed and maintained for the loads which will be placed upon it. The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety of his method or equipment, or from carrying out the work in full accordance with the plans and specifications. No work shall be done until such approval by the Engineer has been obtained.

504.45 Bearings, Expansion Devices and Anchorages. Masonry bearing plates shall not be placed upon bridge seat bearing areas which are improperly finished, deformed or irregular. At bearing pedestal locations the concrete shall be dressed level to the exact elevation shown on the plans, over an area that is 25 mm [1 inch] larger all around than the bearing masonry plate. If a dressed area is below the surface of the surrounding concrete, a channel, 50 mm [2 inches] minimum wide and with a minimum slope of 4 percent, shall be cut to the face of the breast wall, in a location determined by the Engineer. Unless otherwise shown on the plans or directed by the Engineer, bearings shall be placed on preformed pads with dimensions and holes to match the masonry plates.

Anchor bolts may be cast in place during concrete placement or set in drilled holes, at the Contractor's option. If cast in place, the anchor bolts shall be rigidly held during concrete placement by means approved by the Engineer.

If the anchor bolts are set in drilled holes, the anchoring material shall be listed on the Maine Department of Transportation's list of Prequalified Type 1 Anchoring Materials. Holes may be drilled using the masonry plate of the respective bearing as a template. Anchor bolts shall be capable of developing an unconfined pullout strength of 120 kN and 280 kN [30 Kips and 70 Kips] for M24 and M36 [1" and 1½"] anchor bolts respectively in 20 MPa [3000 psi] concrete. Installation shall be in accordance with the manufacturer's recommendations. The unthreaded part of the anchor bolts shall be deformed by swedging or other method acceptable to the Engineer. The minimum cross sectional area of the deformed section of the bolt shall not be less than the tensile stress area of the threaded portion of the bolt. In the completed installation, the anchoring material shall completely fill the annular spaces between the anchor bolts, the

concrete, and the masonry plate and the anchoring material shall be struck off flush with the top of the masonry plate.

The Department reserves the right to perform in-place pullout tests. Any bolts failing to meet the pullout strength requirements above specified shall be repaired or replaced at the Contractor's expense, in a manner approved by the Engineer.

When bronze or copper-alloy bearing and expansion plates are used, the sliding surfaces of the steel in contact with the bearing and expansion plates shall be recoated, just prior to their installation, with a lubricant recommended and supplied by the manufacturer of the bronze or copper-alloy plates.

Unless otherwise indicated on the plans, sliding expansion bearings shall be set so that slotted holes in the sole plate will be centered on the anchor bolts, and rocker bearing assemblies shall be set so as to be plumb, both at 7 °C [45 °F]. In determining any temperature adjustments for adjusting bearings, the difference between the actual steel temperature (not the ambient temperature) and 7 °C [45 °F] shall be used. Changes in span lengths due to dead load deflections shall be considered when setting the bearing assemblies. After all dead loads are substantially in place, the bearings shall be checked and, if necessary, readjusted to conform to the requirements of this specification.

504.46 Straightening Bent Material. Material requiring straightening may be corrected under the provisions of Subsection 504.15, provided that the bend or other deformation is not so extensive or severe as to require replacement of the member, in the opinion of the Engineer.

504.47 Assembling Steel. The parts shall be accurately assembled as shown on the plans and all 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. Surfaces to be in permanent contact shall be cleaned before the members are assembled, unless otherwise specified.

504.48 Field Welding. Welders shall be prequalified in accordance with Subsection 504.49, and all welding shall be in accordance with Subsection 504.20.

Welding shall not be done when the ambient temperature is lower than -18 °C [0 °F], when surfaces are wet or exposed to rain, snow or high winds or when welders are exposed to inclement conditions.

504.49 Field Welder Certification. A field welder must be prequalified in accordance with Subsection 504.20.4. A current Certificate of Authority issued by the State of Maine, Department of Labor, Bureau of Labor Standards or a valid identification/ qualification limits card issued by AWS. No welder shall be authorized to use a welding process other than the welding process(es) for which he or she holds a current certification from either the Department, Bureau of Labor Standards or AWS.

If there is some specific reason to question a welder's ability, then prequalification may be required.

504.50 Misfits. The correction of minor misfits involving non-harmful 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 Engineer and his/her approval of the method of correction obtained. The correction shall be made in his/her presence. If the contract provides for complete fabrication and erection, the Contractor shall be responsible for all misfits, errors and injuries and shall make the necessary corrections and replacements. If the contract is for erection only, the Engineer, with the cooperation of the Contractor, shall keep a correct record of labor and material used and the Contractor shall present to the Engineer for approval, within 30 days, a duplicate itemized bill, made out to the Department.

504.51 Painting Joints and Retouching Defective Paint Areas. As soon as the inspector has examined and approved a completed joint, all exposed surfaces specified to be painted shall be cleaned and thoroughly painted with shop coat paint in conformity with Special Provision 506 -- Painting Structural Steel.

All surface areas from which the shop coat paint has been worn off or has otherwise become defective shall be cleaned in accordance with Special Provision 506 and retouched with shop coat paint.

504.52 Removal of Falsework and Cleanup. Upon completion of the erection and before final acceptance, the Contractor shall remove all falsework, excavated or useless earth material, rubbish and temporary buildings, replace or renew any damaged fences and restore to an acceptable condition all property, both public and private, which may have been damaged during the conduct of his work and shall leave the bridge site and adjacent highway in a neat and presentable condition satisfactory to the Engineer. All excavation and other earth material and falsework placed in the stream channel during construction shall be removed by the Contractor before final acceptance.

504.53 Method of Measurement. Unless otherwise specified, structural steel will be measured as one lump sum complete and accepted, consisting of all metal and related materials in the fabricated and erected structure as shown on the plans, excluding railings and drains. Related materials shall include, but not necessarily be limited to, preformed pads placed under the bearings, and when required, self-lubricating bronze or copper-alloy bearing and expansion plates.

504.54 Basis of Payment. Structural steel will be paid for at the contract lump sum price for the respective contract items involved.

Payment will be made under:

Pay Item	Pay Unit
504.70 Structural Steel Fabricated and Delivered Sum	Lump
504.701 Structural Steel Fabricated and Delivered, Rolled Sum	Lump
504.702 Structural Steel Fabricated and Delivered, Welded Sum	Lump
504.71 Structural Steel Erection	Lump Sum

SECTION 505 -- STUD WELDED SHEAR CONNECTORS, ANCHORS & FASTENERS

505.01 Description. This work consists of furnishing and installing steel stud welded shear connectors, steel stud welded concrete anchors and steel stud welded threaded fasteners in accordance with these specifications and in conformity with the plans. Any Shear Connectors, Anchors and Fasteners, installed for the Contractor's convenience, shall also conform to all applicable provisions of these specifications.

MATERIALS

505.02 Materials. Materials shall meet the requirements of Subsection 711.06, Stud Welded Shear Connectors, Anchors and Fasteners.

CONSTRUCTION REQUIREMENTS

505.03 Construction Requirements. Shear connectors, anchors and fasteners may be either shop welded or field welded using an automatic stud welding gun. Manual welding will not be allowed, except as specified under subsection 505.06, Repairs or when specifically called for on the plans.

Welding shall not be done when the ambient temperature or the temperature of the base metal is below -18 °C [0 °F], when the surfaces are damp or exposed to rain or snow or when the welders or welding operators are exposed to inclement conditions.

Studs shall be end welded to the beams, girders or other structural units with automatically timed stud welding equipment, connected to a suitable power source. If 2 or more stud welding guns are to be operated from the same power source, they shall be interlocked, so that only one can operate at a time and so that the power supply shall have fully recovered from making one weld before another weld is started.

While in operation and after the weld is completed, the welding gun shall be held in position without movement until the weld metal is solidified.

At the time of welding, the studs and the weld area shall be free from any rust, rust pits, scale, oil or other deleterious matter which would adversely affect the welding operation. As directed by the Engineer, the area of the beam, girder or plate to which the studs are to be welded shall be wire brushed, ground free of scale or rust or otherwise cleaned.

Longitudinal and lateral spacing of stud shear connectors, with respect to each other and to edges of beam and girder flanges or plates shall not vary more than 13 mm [$\frac{1}{2}$ inch] from the dimensions shown on the plans, except that a variation of 50 mm [2 inches] will be permitted where required to avoid interference with other attachments on the beam or where a new stud is being welded to replace a defective one. The minimum distance from the edge of a stud shank to the edge of a beam or plate shall be 25 mm [1 inch], but preferably not less than 38 mm [$1\frac{1}{2}$ inches].

505.04 Welding Procedure. The first two stud shear connectors welded on each individual beam, girder, or other structural unit, after being allowed to cool, shall be bent to an angle of 45 degrees from their original axes by striking the studs with a hammer. If failure occurs in the weld zone of either stud, the procedures shall be corrected and two more studs shall be welded to the member and tested. If either of the second two studs fail, additional welding shall be continued on separate plates until two consecutive studs are tested and found to be satisfactory. Two consecutive studs shall then be welded to the member, tested, and found to be satisfactory before any more production studs are welded to the member. The procedure thus established shall be valid for that member only. No studs shall be welded on any beam, girder, or other structural unit, without the above test having been carried out on that member.

The above procedure also qualifies the stud welding operator. No operator shall weld any production studs without first having performed the above test satisfactorily.

If it is found necessary to change any of the parameters of the procedure established for a member, the Engineer shall be notified and the above test shall be performed before any further production welds are made. The test shall also be carried out at the beginning of each day's production.

505.041 Testing (Field or Shop). When the welding of the shear connector studs on a beam or girder is completed, or at such other time as established by the Engineer, the studs shall be visually inspected for incomplete flash (not having a full 360° collar of weld metal around the

base). The studs not having a full flash shall be bent to a 45 degree angle from their original position, in a direction away from the missing flash. When the temperature of the base metal is below 0 °C [32 °F], one stud in each 100 studs welded, shall be bent 45 degrees, in addition to any studs tested as outlined above.

Any stud passing the above tests without developing a crack or tear in either the weld or the shank shall be considered acceptable. Studs that fail the above tests shall be completely removed and replaced.

505.05 Repairs. In areas of the flanges that are always in compression, a new stud may be welded adjacent to the location of a defective stud. In areas that are in tension or subject to stress reversal, a defective stud shall be removed and the area shall be ground smooth and flush before welding a new stud. In case of a pullout of metal, the corrective procedure shall be in accordance with Section 504.

Individual studs, replacing defective studs, may, at the option of the contractor, be fillet welded by the shielded metal arc process as follows:

1. All rust and mill scale in the area to be welded shall be removed from the base metal by grinding.
2. The base of the stud shall be ground so that the outside circumference fits tight against the base metal.
3. The base metal shall be preheated and welded in accordance with the requirements of Subsection 504.20 -Welding. The preheated area shall extend a minimum of 75 mm [3 inches] in all directions around the weld location.
4. Welding shall be done with a 3.18 or 4.76 mm [5/32 or 3/16 inch] diameter low hydrogen electrode.
5. The fillet weld size shall be a minimum of 8 mm [5/16 inch].
6. The welder shall be prequalified in accordance with Subsection 504.49.

505.06 Method of Measurement. Shear connectors will be measured as one lump sum, consisting of all shear connectors required and acceptably installed. Stud welded anchors and fasteners will not be measured for payment, but will be considered incidental to the item for which they are required. Shear connectors, anchors & fasteners installed for the Contractor's convenience will not be measured for payment.

505.07 Basis of Payment. The accepted quantity of shear connectors will be paid for at the lump sum price, complete in place.

Payment will be made under:

Pay Item

Pay Unit

505.08 Shear Connectors

Lump Sum

SECTION 506 -- PAINTING STRUCTURAL STEEL

Reserved

SECTION 507 -- RAILINGS

507.01 Description. This work shall consist of the furnishing of all materials for and the construction of bridge railings and hand railings in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer. Railings will be considered as that portion of a structure attached to curbs, sidewalks, parapets, slabs, retaining walls and steps for the protection of traffic.

MATERIALS

507.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Steel Bridge Rail

Structural Steel	713.01
Preformed Pads	713.03

Aluminum Bridge Rail

Preformed Pads	713.03
Aluminum Railings	716.01

Steel pipe for Steel Pipe Hand Railing shall be steel pipe conforming to the requirements of ASTM A53, Type E or S, Grade A.

CONSTRUCTION REQUIREMENTS

507.03 Steel Bridge Railing.

- (a) Railings shall be fabricated and erected in accordance with the requirements of Section 504 -- Structural Steel. When called for on the plans, railings shall be galvanized to the requirements of AASHTO M111 (ASTM A123) and/or painted in accordance with Special Provision 506 -- Painting Structural Steel.
- (b) Anchor bolts or anchor bolts sleeves shall be set with a template and shall be in their final position prior to the placement of the embedding concrete. Post bearing areas shall be dressed smooth and true to grade.

Preformed pads shall be used in adjusting the rail posts for height and alignment. The number of pads to be supplied shall be 10 percent in excess of the theoretical minimum number required. After erection of the railing, the Contractor shall clean the whole assembly, to present a neat and uniform appearance.

507.04 Steel Pipe Hand Railing. Steel pipe hand railing shall conform to the requirements of Subsection 507.03(a).

507.05 Aluminum Bridge Railing. Aluminum sections may be sheared, sawed or milled. Cut edges shall be smooth and free of burrs. Flame cutting of aluminum will not be permitted.

Holes for rivets shall be drilled full size from the solid or subpunched and reamed.

Rivets shall be cold-driven in the "as-received" condition and the driven head shall be of the cone-point type.

Welding will not be permitted except as specifically called for on the plans or approved by the Engineer. All welding shall be done in conformity with the latest edition of AWS Structural Code, Aluminum D1.2 for aluminum construction. No welding shall be performed prior to the approval of the appropriate welding procedures. No field welding will be permitted.

To facilitate bending, aluminum extrusions of Alloy 6061-T6 or 6351-T5 may be heated to a maximum temperature of 200 °C [400 °F] for a period of not more than thirty minutes.

Threaded fasteners shall be threaded to conform to the requirements of ANSI Standard B1.13M, Class 6g for external and Class 6h for internal threads [ANSI Standard B 1.1, Class 2A for external and Class 2B for internal threads].

Aluminum Bridge Railing shall conform to the requirements of Subsection 507.03(b).

507.06 Method of Measurement. Each type of railing will be measured as one lump sum unit, erected and accepted, in accordance with the dimensions shown on the plans.

507.07 Basis of Payment. Each type of railing will be paid for at the contract lump sum price, complete in place. Payment for painting, when required, shall be included in the lump sum price for the respective railing item.

Payment will be made under:

Pay Item Unit	Pay
507.0811 Steel Bridge Railing, 2 Bar	Lump Sum
507.0821 Steel Bridge Railing, 3 Bar	Lump Sum
507.0831 Steel Bridge Railing, 4 Bar	Lump Sum
507.0841 Steel Pipe Hand Railing	Lump Sum
507.0922 Aluminum Bridge Railing, 2 Bar	Lump Sum
507.0932 Aluminum Bridge Railing, 3 Bar	Lump Sum
507.0942 Aluminum Bridge Railing, 3 Bar with Pales	Lump Sum
507.0951 Aluminum Bridge Railing, Pedestrians	Lump Sum
507.0961 Aluminum Bridge Railing, Pedestrian, with Pales	Lump Sum

SECTION 508 -- MEMBRANE WATERPROOFING

508.01 Description. This work shall consist of furnishing and applying an approved membrane waterproofing to the concrete deck surfaces with a barrier type membrane in accordance with this specification and in conformity with the plans.

MATERIALS

508.02 Materials. The barrier type membrane shall consist of an adhesive primer, preformed sheet waterproofing membrane, and a mastic with all components being as recommended by the manufacturer and approved by the Department as shown on the Prequalified List of Approved Barrier Membranes maintained by the Department.

CONSTRUCTION REQUIREMENTS

508.04 General. Materials shall be stored in such a manner that they are protected from excessive heat and freezing. Priming and membraning shall only be done when the air and concrete temperatures are above 10 °C [50 °F] and the surfaces are dry. Concrete shall be at least fourteen days old prior to applying the primer. The entire surface to be membraned shall be cleaned of all foreign materials, such as oil or grease, and any sharp protrusions removed. Potholes and spalls shall be filled with a product from the Department's Prequalified List of Deck Patching Materials applied in accordance with the Department's approved procedures. Membrane waterproofing on existing structures shall be completely removed to the primed surfaces, except when it can be considered as being compatible with the new membrane, as determined by the Engineer. The removal of existing membrane will only be to the extent, as deemed by the Engineer, to be of a reasonable effort. All surfaces shall then be swept and cleaned by brooms and compressed air as directed by the Engineer.

All areas that are to receive membrane shall be primed and allowed to cure in accordance with the manufacturer's recommendations.

A minimum width 225 mm [9 inch] membrane sheet shall be applied to fit into the recess in the concrete or granite faced bridge curbs. The first full sheet of membrane shall be applied as close as possible to the curb line.

A minimum width 225 mm [9 inch] membrane sheet shall be applied with termination ends at concrete faces the top edge being within 13 mm [1/2 inch] of the top of the bituminous pavement overlay. The first full sheet of membrane at the terminations ends shall be applied as close as possible to the face lines.

Termination edges at ends of slab shall be double covered with membrane by applying an initial strip of 225 mm [9 inch] minimum width centered along the axis of the edge. All edges shall be chamfered and all inside corners filled with a mortar fillet.

All slab construction joints shall first be covered with a minimum 300 mm [12 inch] width of membrane sheet underlayment, applied to the primed surface.

Membrane shall be installed in a shingled pattern so that water is permitted to drain to the low areas of the deck without accumulating against seams, and pressed or rolled into place to assure bond with the primed surface and elimination of air bubbles.

Paving operations shall be done in a manner to permit water to drain to the low area of the deck without entrapment.

The perimeter of all membrane placed in a given day's operation shall receive a seal of mastic over the edge of the membrane. Areas around drains or protrusions shall be liberally coated with mastic at the edges. When the membrane is completed, the perimeter shall receive an additional seal of mastic along the edge of the membrane.

No vehicles other than the bituminous overlay equipment will be permitted on the membrane prior to the bituminous overlay. Overlay equipment wheels and tires shall be clean and free from stones or other material which could penetrate the membrane. Bituminous overlay may be applied over the installed membrane immediately.

Immediately prior to paving over the membrane, the entire surface of the membrane shall be rolled with a rubber tired roller and any air bubbles shall be eliminated by slitting the membrane and forcing the air out. These slits and any ruptures found shall be repaired by applying a membrane sheet at least 150 mm [6 inches] wider than the slit in all directions.

The 25 mm [1 inch] diameter drains in the deck shall be completely opened prior to paving over them. Any drainage slots in the metal roadway drains shall be opened both before and after placing the bituminous pavement.

Overlap of side seams and end laps, application procedures not addressed by this specification, and the laydown temperature of the bituminous overlay shall be in accordance with the manufacturer's recommendations.

508.05 Method of Measurement. Membrane waterproofing will be measured for payment as one lump sum.

508.06 Basis of Payment. Membrane waterproofing will be paid for at the contract lump sum price, which shall be payment in full for furnishing all materials, labor and equipment and all incidentals necessary to satisfactorily complete the work.

Payment will be made under:

Pay Item	Pay Unit
508.13 Membrane Waterproofing	Lump Sum

SECTION 509 -- STRUCTURAL PLATE PIPES, PIPE ARCHES AND ARCHES

509.01 Description. This work shall consist of furnishing and installing structural plate pipes, pipe arches or arches in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established.

MATERIALS

509.02 Materials. Materials shall meet the requirements of the following Subsections of Division 700 -- Materials:

Asphalt Filler for Structural Plate Arches	702.09
Steel Structural Plates	707.09
Aluminum Alloy Structural Plates	707.14

509.03 Fabrication. Structural plate pipes shall be circular with a vertical elongation of approximately 5 percent unless otherwise specified on the plans.

Plates shall be formed to provide lap joints for bolted assembly. Joints shall be staggered so that no more than three plates come together at one point.

Bolt holes shall be made so that all plates having like dimensions, curvature and the same number of bolts per meter [bolts per foot] of seam shall be interchangeable. Each plate shall be curved, before assembly, to the radius necessary to produce the final cross section called for.

End plates shall be neatly cut to the skew and slope shown on the plans. Burnt edges shall be free of oxide and burrs and shall be completely galvanized. Special plates and part plates shall be legibly marked to correspond to markings on an erection diagram which shall be furnished by the Contractor. Two sets of shop detail drawings and erection diagrams shall be supplied to the Engineer.

Bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be staggered in 2 rows, 50 mm [2 inches] apart for steel structural plates and shall be in 2 rows, 44 mm [1¾ inches] apart for aluminum structural plates. Holes shall be in the valley

and crest of the corrugations. Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall be no more than 300 mm [12 inches] apart. The distance from the center of a hole to the edge of the plate shall not be less than 2 times the diameter of the bolt. The nominal diameter of the bolt holes, not including corner holes, in the longitudinal seams shall be 3 mm [1/8 inch] greater than the diameter of the bolts.

509.04 and 509.05 Vacant

CONSTRUCTION REQUIREMENTS

509.06 General. Excavation for the structure and for the bedding material shall be in conformance with Section 206 -- Structural Excavation.

Structures shall be assembled in the sequence and manner recommended by the Fabricator, and in such a way that no distortion of plates will occur. Bolts of the Fabricator's recommended length shall be used in all holes. Nuts shall be tightened to 275 N·m [200 foot pounds] plus or minus 125 N·m [100 foot pounds] of torque. Any nuts loosened by subsequent procedures shall be retightened.

The Contractor shall maintain a minimum cover of 1 m [3 feet] over the top of the structure where construction equipment is used or traffic is maintained.

509.07 Structural Plate Pipes and Pipe Arches. The use of cofferdams and unwatering of the stream will not be a requirement for the installation of pipes and pipe arches unless otherwise specified on the plans. Prior to placing the structure or any plates, the bed shall be brought to the required line and grade and shaped to its required section as much as practicable. When practicable, the pipe or pipe arch shall be moved back and forth longitudinally on the bedding material to shape and compact the bedding material prior to releasing the structure in its final position. The bedding material and structure shall not be placed at times of high water. The Contractor shall obtain approval prior to placing the bedding material and the structure.

The specified bedding material may be omitted if the existing material under the pipe is suitable.

When not otherwise specified on the plans, backfill shall be a selected material of a granular nature with a minimum of clay. It shall contain no frozen material, vegetable matter nor anything which will not pass through a 75 mm [3 inch] square opening screen. The 75 mm [3 inch] size limitation shall not apply to areas 1.5 m [5 feet] or more from the structure.

Fill material shall be deposited evenly on both sides of the structure in layers not exceeding 150 mm [6 inches] in depth, loose measure, until the three-quarter point is reached. It shall be thoroughly compacted under the pipe or pipe arch on both sides of the structure. Above the three-quarter point, fill layers shall not exceed a depth of 200 mm [8 inches], loose measure.

Backfilling and compacting shall be done in the presence of the Engineer.

509.08 Structural Plate Arches. Structural plate arches shall be anchored to concrete substructures by unbalanced channels as shown on the plans. When erection is complete and before any backfilling, the spaces between the structural plates and the legs of the unbalanced channel, on both sides, shall be completely filled with asphalt filler.

When backfilling arches before headwalls are built, a narrow ramp of backfill material shall be built up evenly at each side of the arch and midway between its ends until a minimum cover of 1 m [3 feet] over the top of the arch is reached. The backfill material used in the ramps shall be thoroughly compacted as it is placed. The remainder of the backfill shall be deposited from the top of the ramp, both ways from the center toward the ends as evenly as possible on both sides of the arch.

If the headwalls are built before the arch is backfilled, the same procedure as above shall be followed, except that the backfill material shall first be placed in the form of a narrow ramp adjacent to one headwall. When the aforementioned height above the arch is reached, the backfill material shall be deposited from the top of the ramp toward the other headwall.

In all cases the filling material shall be thoroughly but not excessively compacted. Compacting the backfill by means of flooding or ponding the material with water will not be permitted.

509.09 Method of Measurement. Structural plate pipe, pipe arches and arches will be measured as one lump sum.

509.10 Basis of Payment. The accepted structure will be paid for at the respective contract lump sum price, which price shall include full compensation for preparation of the bed for pipes and pipe arches; and the asphalt filler and unbalanced channel for arches.

Whenever the minimum cover material extends above the subgrade line, the removal of the material which is necessary to complete the work in accordance with the plans will be measured and paid for as Common Excavation as provided in Section 203 -- Excavation and Embankment.

Payment will be made under:

Pay Item	Unit	Pay
509.11 Structural Plate Pipe		Lump Sum
509.12 Steel Structural Plate Pipe Arch:		Lump Sum
509.13 Steel Structural Plate Arch		Lump Sum
509.18 Structural Plate Pipe:		Lump Sum

509.19 Aluminum Alloy Structural Plate Pipe Arch	Lump Sum
509.20 Aluminum Alloy Structural Plate Arch	Lump Sum
509.21 Structural Plate Pipe (Steel or Aluminum Alloy Option)	Lump Sum

SECTION 510 -- SPECIAL DETOURS

510.01 Description. This work shall consist of the design, construction, maintenance in good condition, and removal of temporary structures and approaches required for the satisfactory maintenance of vehicular and pedestrian traffic.

Easements or right-of-way for the Special Detour will be furnished by the Department and will be shown on the contract plans. The Contractor may obtain additional easements at no cost to the Department.

MATERIALS

510.02 Materials. Materials used for the Special Detour structure and approaches shall be approved by the Engineer before they are incorporated in the structure and approaches.

DESIGN REQUIREMENTS

510.03 Vehicular and Pedestrian Traffic Not Separated. The Special Detour shall be located as close as practicable to the new work or as shown on the plans.

Design and details for the Special Detour shall be furnished to the Engineer by the Contractor. The Special Detour including the temporary structure shall be designed and sealed by a Professional Engineer, registered in accordance with the laws of the State of Maine.

The Contractor shall submit detailed plans of the temporary structure and approaches and obtain approval of the Engineer prior to construction. These plans shall be provided in accordance with, and subject to, the conditions of Section 105.02, Plans and Working Drawings, of the Standard Specifications. Also, the design computations relating to the temporary structure shall be submitted for review by the Engineer.

Temporary structures shall be designed in accordance with current AASHTO Standard Specifications for Highway Bridges, except as noted herein, to meet live load requirements of MS18 [HS20]. References to Main Load Carrying Members shall mean those members in which the major stresses result from dead load or live load, or both. Secondary Members are those

members whose primary purpose is to brace the structure against lateral or longitudinal force, or to brace or reduce the unbraced length of main members, or secondary members.

- (a) Structural Steel. Allowable working stresses for tension, compression, and shear in Main Load Carrying Members and Secondary Members and in Steel Grid Floor or Deck as given in the AASHTO Standard Specifications may be increased 35 percent except where age or condition of the steel to be incorporated in the temporary structure may be cause for reduced allowable working stresses. Fatigue stresses need not be considered.
- (b) Deflections. Primary structural members shall be designed so that deflection due to live load plus impact shall not exceed 1/300 of the span.
- (c) Reinforced Concrete. Allowable working stresses for concrete in compression (f_c) and reinforcing steel in tension (f_s) may be increased 50 percent for main load carrying members and floor slabs. Allowable stress in compression for concrete (f_c) shall be limited to the lesser value of $0.6 f_c$ or 12 MPa [1800 psi].
- (d) Timber. Allowable working stresses for extreme fiber in bending (" F_b ") and horizontal shear (" F_v ") may be increased by 50 percent for use as main load carrying members, secondary members, floor or curb provided that material incorporated in the structure is sound and not subject to excessive checks, splits, knots or other deterioration.
- (e) Bridge Railing Loads. Bridge railing shall be designed in accordance with AASHTO Specifications, except that the static design load "P" specified as 44.5 kN [10 kips] may be decreased to 22.3 kN [5 kips]. However, allowable design stresses for material used in bridge rails and posts shall not be increased above those allowed by AASHTO Specifications.
- (f) Waterway Opening. The minimum waterway opening of the temporary structure shall be designed to pass the discharge indicated in the Contract Specifications, without any overtopping of the roadway.

The geometric design of the Special Detour, except as otherwise shown on the plans or as noted herein, shall be designed in accordance with the current AASHTO Specification "A Policy on Geometric Design of Highways and Streets".

- (a) Horizontal Alignment. Horizontal curve radius shall not be less than 60 m [200 feet] at the centerline of roadway, except as approved by the Engineer.

Roadway width as indicated in the proposal shall be the minimum clear traveled width between face of bridge curbs. Bridge curb shall be between 150 and 225 mm [6 inches and 9 inches] high. The roadway face of bridge rail shall be located

75 mm to 150 mm [3 inches to 6 inches] behind the face of curb. The approach roadway shall have minimum 600 mm [2 foot] shoulders to the roadway berms or to the face of approach road guardrail in addition to the roadway width indicated in the proposal.

The roadway width shall be increased on curved portions of the Special Detour to account for the off tracking characteristics of a WB-62 vehicle in accordance with Table III-20, Case I or Case III of the AASHTO Specification.

- (b) Vertical Alignment. Grades shall not exceed 10 percent and any change in grade shall accommodate all legal highway vehicle components or attached loads.
- (c) Approach Road Guardrail. The Special Detour approaches shall have guardrail where side slopes are steeper than three horizontal to one vertical. Approach guardrail shall be attached to the bridge guardrail in a manner that develops the approach guardrail in tension. Approach guardrail shall consist of Type 3 guardrail or an approved equal unless other rail or barriers are specified.

The termination of approach guardrail and the end treatment of the rail shall be in accordance with the current AASHTO Roadside Design Guide.

- (d) Approach Road Base Drainage. The approach road base structure shall consist of a minimum of 300 mm [1 foot] thick layer of aggregate subbase course gravel, Type D or E and the layer shall be designed to support legal loads during the use of the detour. Drainage shall be designed to drain the approach area.
- (e) Approach Road Surface. The approach surface shall be approved gravel, except when specified to be paved, and shall be maintained in a compacted and smooth condition.
- (f) Design Speed. The design speed of the Special Detour shall be not less than the construction area posted speed limit, or the advisory speed limit, as applicable, unless otherwise indicated in the contract specification.

510.041 Pedestrian Traffic Only. The provisions of Subsection 510.03 shall apply to this subsection with the following modifications:

- (a) Structures shall be designed for a live load of 4 kN/m² [85 pound per square foot].
- (b) The detour shall have a minimum clear width of 1.50 m [5 feet] or as specified on the contract plans or specifications.
- (c) Ramps shall be provided to allow access to wheelchair or handicapped persons.

(d) Deflections due to live load shall not exceed 1/300 of the span.

510.042 Vehicular and Pedestrian Traffic Separated. The provisions of both Subsections 510.03 and 510.041 shall apply to this subsection. If vehicles and pedestrians are carried on the same structure, each shall have its own lane as specified. The pedestrian lane shall be protected from vehicular traffic by being at least 225 mm [9 inches] above the roadway surface or suitably protected by means of an adequate curb at least 225 mm [9 inches] in height above the roadway surface. No bridge rail will be required between vehicle traffic and pedestrian traffic, but shall be located at the exterior side of the sidewalk.

CONSTRUCTION REQUIREMENTS

510.051 Vehicular and Pedestrian Traffic Not Separated. The Special Detour, including temporary structures shall be constructed in accordance with the plans submitted by the Contractor and approved by the Engineer. Barricades, warning signs, lights and other traffic control devices shall be provided in accordance with the project traffic control plan requirements.

Deck and floor members shall be fastened or anchored so that all contact surfaces with adjacent supporting members bear continuously. Immediate corrective action shall be taken by the Contractor to remedy any condition in the structure that results in objectionable or distractive noise levels when subject to traffic loads.

If a wood plank deck is used, it shall be secured into wood nailer strips, or secured by an alternate method acceptable to the Engineer.

Provisions shall be made for a skid resistant wearing surface throughout the period of time the temporary structure is open to public travel for vehicular and pedestrian traffic. A steel grid floor may be used for vehicular traffic if installed in accordance with approved design plans and these specifications.

Prior to opening the temporary structure to traffic, the Professional Engineer responsible for the design shall certify in writing to the Department that the structure was constructed in conformance with the approved plans and design details.

510.052 Pedestrian Traffic Only. The provisions of Subsection 510.051 shall apply, however, screw type nails will not be required to anchor wood plank for pedestrian traffic use.

510.053 Vehicular and Pedestrian Traffic Separated. The provisions of both Subsections 510.051 and 510.052 shall apply.

510.06 Contractor's Responsibility. The provisions of Sections 104, 105, 107, and 652 shall apply to work under this section. The Contractor shall be responsible for removal of snow from

areas provided for pedestrian traffic as well as vehicular traffic in accordance with Section 104. In addition to normal maintenance, should any part or all of the detour be damaged or destroyed by high water or any other cause prior to opening the highway to traffic, it shall be repaired or replaced by the Contractor without additional compensation.

Erosion control shall be accomplished in accordance with Subsection 107.26, Soil Erosion and Water Pollution Control. An Erosion Control Plan shall be submitted for approval by the Engineer with the plans and details of the detour.

510.07 Removal of Detour. When the highway has been opened to traffic, the temporary structure and approaches shall be removed to or below the streambed or finish ground line and the approaches shall be obliterated and stabilized to original or better than original conditions. The provisions of Section 104 shall apply.

510.08 Method of Measurement. Special detours will be measured for payment by the lump sum.

510.09 Basis of Payment. The accepted special detour will be paid for at the contract lump sum price which price shall be full compensation for the respective items, as called for in the contract, designed, constructed, maintained, completely removed and the affected areas rehabilitated and stabilized, including loaming, seeding and mulching.

When erosion control is required due to runoff from the detour roadway surface, erosion control will be paid under applicable contract items. Other erosion control work required for the special detour will not be paid for directly and all costs for such erosion control will be considered included in the lump sum payment for special detour. Traffic control devices, pavement, and dust control will be paid for under the applicable contract items.

Payment will be made under:

Pay Item

Pay Unit

510.10 Special Detour, ____ meter [foot] Roadway Width Vehicular and Pedestrian Traffic Not Separated	Lump Sum
510.11 Special Detour, Pedestrian Traffic Only	Lump Sum
510.12 Special Detour, ____ meter [foot] Roadway Width Vehicular and Pedestrian Traffic Separated	Lump Sum

SECTION 511 -- COFFERDAMS

511.01 Description. This work shall consist of the complete construction, maintenance and removal of all cofferdams, caissons, cribs, sheeting, embankments, temporary diversion channels and other similar work, including unwatering, required to allow for the excavation of foundation pits and to permit and protect the construction of structural units, in accordance with these specifications.

MATERIALS

511.02 Materials. If requested, the Contractor shall submit for approval, plans showing the materials to be used and the proposed method of protecting the foundation construction. Construction shall not be started on cofferdams until such plans are approved. Approval of the plans shall not relieve the Contractor of the responsibility for the satisfactory functioning of the cofferdam.

CONSTRUCTION REQUIREMENTS

511.03 Cofferdam Construction. Cofferdams shall, in general, be carried well below the elevation of the bottom of footings and shall be well braced and as watertight as necessary for the proper construction of the foundation. Unless it is contemplated that a concrete foundation seal will be placed under water, the interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction and inspection of forms and to permit pumping outside of forms. Cofferdams shall be so constructed that sea water will not come in contact with concrete, as required in Section 502 -- Structural Concrete.

During the placing of seal concrete, the elevation of the water inside the cofferdam shall be controlled to prevent any flow through the concrete.

No timber or bracing shall be used in cofferdams or cribs in such a way as to remain in the substructure masonry.

Cofferdams shall be constructed so as to protect fresh concrete against damage from the sudden rising of the stream and to prevent damage by erosion.

Unless otherwise provided, cofferdams or cribs, including all sheeting and bracing involved, shall be removed after the completion of the substructure, care being taken not to disturb or otherwise injure the finished masonry.

All embankments serving as cofferdams shall be removed, temporary diversion channels filled in, and all areas left in a neat and workmanlike appearance and in an approved stabilized condition.

511.04 Pumping. Pumping from the interior of any foundation enclosure shall be done in such manner as to prevent any current of water which would carry away or segregate the concrete.

Pumping to unwater a sealed cofferdam shall not commence until the seal concrete has set sufficiently to withstand the hydrostatic pressure but in no case will pumping be permitted within 5 days under normal conditions or 7 days when the temperature of the water outside the cofferdam is less than 4 °C [40 °F].

All water and materials pumped from cofferdams shall be pumped into a sedimentation basin which is of sufficient volume to detain the pumped water and materials. The water and materials removed from the cofferdam(s) shall be pumped at a rate that permits infiltration of the water into the earth, preventing any overland flow or direct discharge into a stream or other body of water.

511.05 Method of Measurement. Cofferdams will be measured as one lump sum unit, as indicated on the plans or called for in the contract.

511.06 Basis of Payment. The accepted quantity of cofferdam will be paid for at the contract lump sum price for the respective cofferdam items.

When required, the elevation of the bottom of the footing of any substructure unit may be lowered, without change in the price to be paid for Cofferdams, provided, however, that if the average elevation of more than 25 percent of the area of the excavation is more than 1 m [3 feet] below the elevation shown on the plans, and at the Contractor's request, the entire cost of the cofferdam will be paid for in accordance with Subsection 109.04 instead of at the contract lump sum price.

All costs of constructing, maintaining, and removing a sedimentation basin, and pumping or transporting water and other materials to the sedimentation basin will not be paid for directly, but will be considered incidental to the cofferdam pay item(s).

Payment will be made under:

Pay Item	Pay Unit
511.07 Cofferdam	Lump Sum

SECTION 512 -- FRENCH DRAINS

512.01 Description. This work shall consist of furnishing, placing and compacting stone and gravel for French Drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established.

MATERIALS

512.02 Materials. Materials shall meet the requirements of the following Subsections of Division 700 -- Materials.

Aggregate for Subbase	703.06(b)
Gravel Borrow	703.20
Stones for French Drains	703.24

Gravel for French Drains shall meet the requirements of either Aggregate for Subbase, Type D or Gravel Borrow at the Contractor's option.

CONSTRUCTION REQUIREMENTS

512.03 Drains. Stones shall be placed behind and against the structures with the bottom of the stones at the elevation of the flow line of the weeper drains. The stones shall form a box section, 600 mm [2 feet] wide and 600 mm [2 feet] high, for the entire length of the structure. Gravel shall be placed to form a box section around the stones, to the limits of 600 mm [2 feet] above the stones, 600 mm [2 feet] behind the stones and 600 mm [2 feet] below the stones, but not to be placed below the top of the footing.

Gravel for French Drains shall be compacted in the same general manner and to the same extent as the adjacent embankment.

512.04 Method of Measurement. French Drains will be measured as one lump sum unit, satisfactorily placed and accepted.

Excavation for French Drains will be measured for payment in accordance with Section 206 -- Structural Excavation.

512.05 Basis of Payment. French Drains will be paid for at the contract lump sum price, complete in place.

Payment will be made under:

Pay Item	Pay Unit

SECTION 513 -- SLOPE PROTECTION

513.01 Description. This work shall consist of excavating for and placing a protective covering on designated slopes in accordance with these specifications and in reasonably close conformity with the lines, grades and thickness as shown on the plans or established.

MATERIALS

513.02 Materials. Materials shall meet the requirements of the following Subsections of Division -- 700 Materials.

Crushed Stone	703.31
Reinforcing Steel	709.01

Portland cement concrete for slope protection shall be Class "AA" and shall meet the requirements of Section 502 -- Structural Concrete.

CONSTRUCTION REQUIREMENTS

513.03 Portland Cement Concrete. The slope on which the concrete for slope protection is to be placed shall be free of frost and frozen material and shall be well compacted. If additional fill material is required to bring the slope to the proper grade, it shall be of the same type material as that required for the slope protection foundation. Immediately prior to placing the concrete the area to be covered shall be thoroughly dampened.

The portland cement concrete shall be placed in alternate sections. Each individual section shall be placed by starting at the lowest extremity of the section and progressing upward on the slope. The reinforcement shall not extend through the construction joints and the bond between sections shall be broken by the application of an approved asphalt cement on the edges of the previously placed slabs.

The surface of the concrete shall be float finished in accordance with the requirements of Section 502 -- Structural Concrete and textured by brooming lightly and uniformly with an approved broom. An edging tool shall be used on the surface edges of each section and a groover

at the transverse centerline of each section. The exterior surface from the edging or grooving shall be finished to match the interior surface.

Construction procedures shall be in accordance with Section 502 -- Structural Concrete, except that the curing period will be five days.

513.04 Crushed Stone. Crushed stone shall be placed on granular material as shown on the plans. The finished slope shall be worked to present a smooth and uniform surface.

513.05 Method of Measurement. Slope protection will be measured by the number of square meters [square yards] of surface area acceptably covered in accordance with the plans and specifications.

513.06 Basis of Payment. The accepted quantity of slope protection will be paid for at the contract unit price per square meter [square yard]. Payment will be full compensation for excavating, shaping and compacting the slope prior to placing bedding and slope protection and shall also include the bedding material. Excavating from original ground to the face of the slope protection will be paid under the appropriate contract item.

Payment for portland cement concrete slope protection shall be full compensation for furnishing and placing all material, including reinforcement, and for all labor and other incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Unit	Pay
513.09 Slope Protection-Portland Cement Concrete	square meter [Square Yard]	
513.22 Crushed Stone Slope Protection	square meter [Square Yard]	

SECTION 514 -- CURING BOX FOR CONCRETE CYLINDERS

514.01 Description. This item shall consist of furnishing, installing, operating and maintaining an approved thermostatically controlled curing box for concrete test cylinders, with the equipment as herein specified.

514.02 General. The curing box shall be for the sole use of the Engineer for the duration of the contract. The Contractor shall relocate the curing box to a new location, as directed, whenever considered necessary during the progress of the work. The Contractor shall furnish the electrical power and all utility connections necessary for the operation of the curing box. The Engineer

shall be provided 2 locks, each with 2 keys, to be used with the 2 securing latches. A lock for the switch box, with 2 keys shall be furnished.

CONSTRUCTION REQUIREMENTS

514.03 Construction Details. The curing box for 150 mm [6 inch] diameter by 300 mm [12 inch] long concrete cylinders shall have dimensions sufficient to allow storage of a minimum of 18 cylinders. The top of the curing box shall be a lid hinged at the back with at least 2 securing latches on the front suitable for sealing and locking the curing box. The free movement of the lid shall be restricted to an angle of approximately 100 degrees from the closed position to an open position. For metal boxes subject to corrosion, all interior surfaces shall have rustproof protection and the exterior surfaces shall be substantially painted with an approved paint. A moisture-proof seal, constructed of an approved cellular strip of 2BE520F26 synthetic rubber complying with the requirements of ASTM D2000, shall be provided between the lid and body of the curing box.

The curing box shall be constructed so that the required temperature and humidity within the box can be supplied by an immersible heater, minimum 1000 watts, when immersed in a pool of water, approximately 100 mm [4 inches] in depth at the bottom of the box. The heating element shall be located so as to provide free access for cleaning and for adequate circulation of the surrounding water. A drain shall be provided for the water, located at the lower front edge of the box. Access shall be provided to all parts of the box for cleaning. The electrical utility connection to the source of power shall be made in a lockable switch box which is securely attached to one end of the curing box.

All electrical connections from the curing box to the utility connection shall conform to the latest requirements of the NEC. The curing box shall be effectively grounded. Grounding shall be accomplished in one of the following ways:

- (a) By means of a grounding conductor run with the circuit conductors in cable assemblies or flexible cords, provided an approved plug is used, 1 fixed contacting member for the purpose of connecting such grounding conductor to the grounded metal raceway or to a grounding conductor installed only for equipment grounding purposes; the grounding conductor in a cable assembly may be uninsulated but where an individual covering is provided for such conductors it shall be finished to show a green color.
- (b) A direct connection from the grounding wire (green color) on the Curing Box wiring to a 2.4 m [8 foot] non-ferrous metal driven ground rod and ground rod clamp.

For installation, where the Curing Box is outside and exposed to the weather, all wiring and fittings shall be of the weatherproof type.

An approved bimetallic thermometer shall be installed that will measure the internal temperature of the curing box. The thermometer shall have minimum gradations of 1 °C [2 °F] and a minimum face diameter of 75 mm [3 inch], open to the outside. The thermometer shall be easily read from a distance and shall be protected from physical damage by suitable shielding. Substantial folding handles shall be provided on the end of the box for use in moving.

The curing box shall be suitable for maintaining an internal temperature of 21 °C [70 °F] plus or minus 3 °C [5 °F] when the ambient temperature is as low as -25 °C [-10 °F].

514.04 Method of Measurement. Curing box for concrete cylinders will be measured by each unit, furnished and satisfactorily maintained.

514.05 Basis of Payment. The accepted quantity of curing box for concrete cylinders will be paid for at the contract unit price each, which payment shall be full compensation for furnishing and maintaining, for all materials, labor, tools, equipment, electrical power, temporary utility changes and adjustments, and all necessary incidentals. At the completion of the contract, the Curing Box shall remain the property of the Contractor and shall be removed from the site of the work.

Payment will be made under:

Pay Item	Pay Unit
514.06 Curing Box for Concrete Cylinders	
Each	

SECTION 515 -- PROTECTIVE COATING FOR CONCRETE SURFACES

515.01 Description. This work shall consist of furnishing and applying a protective coating on concrete surfaces as called for on the plans or as designated by the Engineer in accordance with these specifications.

MATERIALS

515.02 Materials. Materials shall meet the requirements of Subsection 711.05, Protective Coating for Concrete Surfaces.

CONSTRUCTION REQUIREMENTS

515.03 Surface Preparation. On surfaces to be treated all voids shall be filled with mortar and the entire surface shall be dressed by dry rubbing to remove form marks and blemishes to present a neat appearance. The concrete shall remain dry for at least 48 hours before treatment and shall be free of laitance, oil, grease, dirt and dust. All traces of dust shall be removed immediately before applying the linseed oil mixture.

The treatment shall not be done until at least 14 days after casting the concrete and completed at least 24 hours before the treated portion is opened to traffic.

515.04 Application. Enough material shall be used to coat the surfaces thoroughly. Two coatings shall be applied 24 hours or more apart. The minimum rates of application shall be 0.10 L/m² [.025 gallons per square yard] for the first coat and 0.07 L/m² [.015 gallons per square yard] for the second coat.

The method of application may be dependent on available equipment and the area involved. Hand spray methods or pressure distributors may be used and application by rollers or brushes may be desirable under some conditions. Care shall be taken to prevent discoloration of areas and parts not requiring treatment.

Twenty four hours after application, excess coating materials, if any, must be removed.

When practical, treatment of the concrete surfaces shall be completed before exposure to deicing salts. The temperature of the concrete shall be above 4 °C [40 °F].

515.05 Method of Measurement. Protective coating for concrete surfaces will be measured for payment by the square meter [square yard] or lump sum unit as specified, satisfactorily applied and accepted.

515.06 Basis of Payment. Protective coating for concrete surfaces will be paid for at the contract unit price per square meter [square yard] or lump sum as specified.

Payment will be made under:

Pay Item	Pay Unit
515.20 Protective Coating for Concrete Surface	square meter [Square Yard]
515.21 Protective Coating for Concrete Surfaces	Lump Sum

SECTION 516 -- STYRENE-BUTADIENNE LATEX MODIFIED PORTLAND CEMENT MORTAR AND CONCRETE

Reserved

SECTION 517 -- SHOTCRETE

Reserved

SECTION 518 -- REHABILITATION OF STRUCTURAL CONCRETE BRIDGE DECKS

518.01 Description. This work shall consist of the removal and replacement of existing concrete required for the rehabilitation of the top of an existing bridge slab and the surface of existing curbs and sidewalks, as shown on the plans or as directed by the Engineer. All work shall be in conformity with the applicable provisions of Section 202 -- Removing structures and Obstructions; Section 502 -- Structural Concrete; and Section 503 -- Reinforcing Steel; of the applicable Standard Specifications, Supplemental Specifications and Special Provisions.

MATERIALS

518.02 Materials. Replacement of existing concrete removed shall be made in accordance with the following:

- (a) Class AA concrete shall be used where depths of placement are greater than 25 mm [1 inch]. Surface preparation, bonding grout, and grout application shall be as specified under Subsection 518.07, except brooming or brushing underneath reinforcement will not be necessary.
- (b) Where the depth of placement of any part of a placement area is less than 25 mm [1 inch] the material shall be one of the products listed on the Maine Department of Transportation's list of Prequalified Patching Materials.

Prior to placing any patching material, the type of patching material, surface preparation method and application procedure must be approved by the Engineer.

CONSTRUCTION REQUIREMENTS

518.03 General. All work shall be done in a manner to accommodate the Maintenance of Traffic Requirements.

Removal of existing concrete for rehabilitation work shall be accomplished with either an approved scarifying machine or a maximum 16 kg [35 pound] chipping hammer or pavement breaker.

The perimeter of the cavity created by the removal of concrete shall be approximately perpendicular to the original surface and shall be sawcut to a minimum depth of 13 mm [1/2 inch]. Edges of the cavity shall not be feathered.

Removal of existing concrete shall be accomplished without damage to the portion of the structure which is to remain. The surfaces to receive new concrete or patching material shall be free of oil, solvent, grease, dirt, dust, bitumen, loose particles, and foreign matter.

Air lines shall be equipped with effective oil traps. The cleaning of an area of the deck shall be performed within the 24 hour period preceding placement. The cleaning shall be performed by dry sand blasting or other methods approved by the Engineer.

All debris from the cleaning operation shall be thoroughly removed by compressed dry air from the cleaned surfaces and adjacent areas. The cleaned areas shall be protected against contamination prior to placement of the concrete or patching material. Contaminated areas shall be recleaned by dry sand blasting.

518.04 Structural Concrete Slab. After the existing wearing surface has been removed and after the slab has been scarified, if called for, the Engineer will inspect the existing concrete surfaces to determine where deteriorated concrete is to be removed. The areas of deteriorated concrete to be removed will be laid out and marked on the slab by the Engineer.

The depth of removal shall be subject to approval of the Engineer and shall be sufficient to insure that all unsound concrete is removed. Where removal is required to below the top of the main reinforcing steel, the concrete shall be removed to a minimum of 25 mm [1 inch] below the bottom of the main reinforcing steel.

When a new structural concrete wearing surface is to be placed on the existing deck, replacement of the existing structural concrete removed "to reinforcing steel" shall be made by placing monolithically with the specified new structural concrete wearing surface. Replacement of the existing structural concrete removed "to below reinforcing steel" or "removed full depth" shall be replaced to the level of the deck surface and properly cured, as directed by the Engineer, prior to placement of the new wearing surface.

The surface of the existing concrete slab and the replacement concrete shall be prepared in accordance with Subsection 502.11(g) prior to placement of a new concrete wearing surface.

518.05 Concrete Curbs and Sidewalks. The area of existing concrete to be rehabilitated in curbs and sidewalks will be laid out and marked by the Engineer. The extent of removal shall be

subject to approval of the Engineer and shall be sufficient to insure that all unsound concrete is removed.

Inclined surfaces shall be removed to a minimum of 25 mm [1 inch] behind the nearest plane of reinforcing steel. An inclined surface will be considered as any surface greater than 30 degrees from horizontal.

518.06 Reinforcing Steel. All existing reinforcing steel exposed by concrete removal, which is to remain in the bridge, shall be cleaned of all loose rust by sand blasting, wire brushing or by machine wire brushing. Care shall be taken, where reinforcing is uncovered, not to damage the steel which is to remain in the bridge or to damage its bond to the surrounding concrete.

All existing main reinforcing steel which is broken or has lost 25 percent or more of the original cross sectional area shall be supplemented with new reinforcing steel of the same diameter. Supplementary reinforcing steel shall be lapped 30 bar diameters and wired to the existing steel or, where designated by the Engineer, the existing reinforcing steel shall be cut and the supplementary reinforcing steel spliced in with tension couplers.

518.07 Bonding Grout. The supporting slab shall be free of excess moisture prior to placement of the bonding grout.

All horizontal surfaces in contact with replacement concrete shall receive a coating of bonding grout. Except as otherwise approved by the Engineer, the grout shall be applied from a metal or plastic container which has a series of 10 mm [3/8 inch] diameter holes uniformly spaced on the bottom and close to the bottom on the sides. As much as practicable, stiff, bristled, nylon, street brooms shall be used to brush the grout onto the surface. In general, the coating shall not exceed 3 mm [1/8 inch] in thickness. The rate of progress in applying grout shall be limited so that the grout does not become dry before it is covered with new concrete.

During delays in the rehabilitation operations, should the surface of the grout indicate an extensive amount of drying, additional grout shall be brushed on the area, as directed by the Engineer. In areas where the grout becomes thoroughly dried, the grout shall be removed by sand blasting or other methods as approved by the Engineer.

The bonding grout shall have portland cement and fine aggregate proportioned 1 to 1 by volume. The fine aggregate from which the material larger than 3 mm [1/8 inch] has been removed shall be the same source as used in the concrete.

The cement and fine aggregate shall be measured separately in equal size containers. The fine aggregate shall be deposited in an approved mechanical mortar mixer prior to adding cement. Water shall be added in sufficient quantity to result in a workable consistency. Workable consistency is defined as the minimum of water necessary to allow flow of most of the grout without segregation of the grout ingredients. No further water shall be added. The grout shall not be allowed to separate prior to placement. The cement to water contact time of the grout shall not

exceed 30 minutes before it is placed. Any grout that has dried or become unworkable prior to application, as determined by the Engineer, shall not be incorporated into the work.

518.08 Method of Measurement. The rehabilitation of structural concrete slab will be measured for payment by the square meter [square foot], complete and accepted.

Measurement of each area of the concrete slab rehabilitated will be applied to only one of the contract items provided. Determination of the applicable item will be made based on the actual depth of concrete removed.

The rehabilitation of concrete curbs and sidewalk will be measured for payment by the square meter [square foot], complete and accepted. Measurement will be made parallel to the surface being repaired.

Supplementary reinforcing steel will be measured for payment by the kilograms [pounds] of steel installed and paid for under Item 503.12, Reinforcing Steel, Fabricated and Delivered, and Item 503.13 Reinforcing Steel Placing, except that Reinforcing Steel Placing, will be measured for payment as 1.5 times the actual kilograms [pounds] placed.

Tension couplers will be measured for payment as the number of splices satisfactorily installed and accepted. Payment will be made under Item 503.17, Mechanical/Welded Splices.

518.09 Basis of Payment. The rehabilitation of structural concrete slab and concrete curbs and sidewalks will be paid for at the contract unit price as indicated in the Schedule of Items for the respective contract item involved.

Payment for the removal of concrete and the furnishing and placing of new concrete, or other designated repair material, in areas where concrete is removed will be included in the unit price for the respective concrete rehabilitation items.

The cleaning of existing reinforcing steel to remain in the bridge shall be incidental to the related contract items.

The satisfactory disposal of all removed material shall be considered as incidental to the related contract items.

The payment for each contract item will also be full compensation for furnishing all materials, labor, equipment, for all form work, and for all other incidentals necessary to complete the work.

Payment will be made under:

Pay Items

Pay Unit

518.30 Rehabilitation of Structural-Concrete Slab o Reinforcing Steel	square meter [Square Foot]
518.31 Rehabilitation of Structural-Concrete Slab to Below Reinforcing Steel	square meter [Square Foot]
518.32 Rehabilitation of Structural-Concrete Slab Full Depth	square meter [Square Foot]
518.34 Rehabilitation of Structural-Concrete Slab Sidewalks -Inclined Surfaces	square meter [Square Foot]
518.35 Rehabilitation of -Structural Slab Concrete Sidewalks Horizontal Surfaces	square meter [Square Foot]

SECTION 519 -- VACANT

SECTION 520 -- EXPANSION DEVICES -- NON-MODULAR

520.01 Description. This work shall consist of furnishing and installing expansion devices including the seals, anchorage system and curb and sidewalk expansion dams where required, as shown on the plans and in accordance with these specifications.

Seals for expansion devices shall be either gland seals or compression seals as specified on the plans.

520.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Expansion Device - Gland Seal

Metal Bridge Paint (Shop Coat)	708.02
Anchor Studs	711.06
Structural Steel	713.01
High Strength Bolts	713.02
Steel Extrusions	713.08
Elastomer for Seal Elements	714.01
Lubricant-Adhesive	714.03
Gland Type Seals	714.06

Expansion Device - Compression Seal

Metal Bridge Paint (Shop Coat)	708.02
Anchor Studs	711.06
Structural Steel	713.01
High Strength Bolts	713.02

Elastomer for Seal Elements	714.01
Lubricant-Adhesive	714.03
Compression Seals	714.05

Steel shapes and plates shall meet the requirements of ASTM Specification A36/A36M, A588/A588M, A572/A572M Grade 345 [Grade 50], or other weldable steel meeting the approval of the Engineer.

Gland seals shall be of the general configuration as shown on the plans and shall be one of the seals, listed on the Maine Department of Transportation list of prequalified gland seals.

Acceptance of the materials for Expansion Devices will be based on a Materials Certification Letter as specified in Division 700 -- Materials Details.

CONSTRUCTION REQUIREMENTS

520.03 Fabrication. Fabrication of Expansion Devices shall be in conformance with the applicable provisions of Section 504 -- Structural Steel, and Supplemental Specifications 504 -- Structural Steel (Welding).

Seals shall be furnished and installed in one continuous length and splices will not be allowed except as specified hereafter.

As received from the supplier of the seal, seals may contain one splice for each continuous length of 15 m [50 feet] or greater. Sections under 15 m [50 feet] long shall not have any splices. Splices at abrupt angular changes in horizontal alignment will be allowed. Splices in gland type seals shall be shop vulcanized by the seal supplier. Splices in compression seals may be either vulcanized or adhesive bonded. At abrupt angular changes in vertical alignment, the lower 75 percent of the depth of compression seals may be cut to allow short radius bends.

Seal elements shall be installed in accordance with the manufacturer's recommendations, using equipment manufactured specifically for the installation of said element. The equipment shall not cause structural damage to either the seal or the joint armor and shall not twist, distort or cause other malformations in the installed seal element. Any perforation or tearing of a seal element due to installation procedures or construction activities, will be cause for rejection of the installed seal element.

Immediately prior to the installation of the seal element, the metal contact surfaces of the joint armor shall be clean, dry and free of oil, rust, paint or foreign material. The contact surfaces of the seal element shall be cleaned with normal butyl-acetate, using clean rags or mops, immediately prior to application of the lubricant-adhesive or sealant. The lubricant adhesive or

sealant shall be applied to the seal element and joint armor contact surfaces at the rate recommended by the manufacturer of the seal.

The exposed ends of compression seals shall be sealed, after installation, with appropriately shaped pieces of foam rubber, bonded in place with an appropriate bonding agent approved by the Engineer or shall be sealed by such other method as may be approved by the Engineer.

520.04 Painting. When structural steel is specified to be painted, the expansion device including the expansion dams shall be painted in accordance with Special Provision 506 -- Painting Structural Steel. When structural steel is specified to be unpainted, the expansion device, including expansion dams, shall receive three coats of shop paint on the underside areas of exposed steel.

When specified on the contract plans, reinforcing steel shall be anchored into drilled holes.

520.05 Delivery. Unless otherwise specified on the plans, expansion devices shall be shipped fully assembled and shall be installed as a unit. The unit shall be equipped with shipping and temperature adjustment devices approved by the Engineer, and shall be preadjusted, in the shop, to the opening required at 7 °C [45 °F].

520.06 Installation. Expansion Devices shall be erected following placement of the structural deck slab. The devices shall be lowered in the blocked-out area of the deck slab, adjusted for the temperature as directed by the Engineer, set to the proper height and fastened in place. Immediately following this, all shipping and temperature adjustment devices shall be removed and the blocked-out concrete for the slab and abutment backwall may be placed.

520.07 Method of Measurement. Expansion devices will be measured by each unit, complete in place and accepted. Each unit shall consist of one pair of matching elements, including anchorage system, seal, shipping and temperature adjustment devices and expansion dams as required.

520.08 Basis of Payment. The accepted quantity of expansion devices shall be paid for at the contract unit price each, which shall be full compensation for all materials including anchorage system, shop paint, equipment, labor and incidentals necessary for furnishing and installing the expansion devices and, if specified, curb and sidewalk expansion dams.

Payment will be made under:

Pay Item	Pay Unit
520.21 Expansion Device - Gland Seal	Each
520.22 Expansion Device - Compression Seal	Each

SECTION 521 -- FINGER JOINT AND FABRIC TROUGH

521.01 Description. This work shall consist of fabricating and installing finger joint expansion devices and fabric troughs when required, including the anchorage system, curb and/or sidewalk expansion dams, support structure for fabric troughs when required, and any metal downspout(s) and/or chute(s) required to guide the discharge from the trough(s) when required, and all necessary materials and equipment required to complete the work as shown on the plans and in accordance with these specifications.

FINGER JOINT

521.02 Materials. Plates and shapes shall conform to the requirements of AASHTO M183/M183M (ASTM A36/A36M), tubes shall conform to the requirements of ASTM A500, Grade "B", or ASTM A501, anchor studs shall conform to AASHTO M169 (ASTM A108), Grades 1010 through 1020, semi-killed or fully-killed, and bolts shall conform to AASHTO M169M (ASTM A325M) [AASHTO M169 (ASTM A325)], Type 1.

521.03 General. Expansion devices shall be fabricated in conformity with the requirements of Section 504 - Structural Steel of the Standard Specifications. Completed expansion devices and any required downspouts and/or chutes shall be hot dipped galvanized to the requirements of AASHTO M111 (ASTM A123). Anchorage parts encased in concrete may be supplied in the ungalvanized condition.

Each expansion device shall be shipped fully assembled, shall be installed as a unit, and shall be equipped with shipping and temperature adjustment devices approved by the Engineer. When a project is built in stages, and if desired by the Contractor, the expansion device may be shipped in two or more sections, as approved by the Engineer, with appropriate provisions for field splicing.

FABRIC TROUGH

521.04 Materials

The fabric for the trough shall be 3 to 5 mm [1/8"-3/16"] in thickness and shall consist of a single layer of 415 g [14.6 oz.] woven nylon fabric, or the equivalent in multiple layers of woven nylon fabric, laminated between two or more layers of neoprene rubber. The neoprene shall conform to the requirements of AASHTO specification M251 amended as follows:

Physical Properties:

Grade (Duro)

60

Original Physical Properties
Hardness ASTM D2240 60+/-5

Tensile Strength, Minimum 13.8 MPa [2,000 psi]
ASTM D412

Elongation at Break, Minimum 300%

Accelerated Test to Determine Long Term
Aging Characteristics

Oven Aged - 70 Hours/100 °C

[70 Hours/212 °F], ASTM D573

Hardness, Points Change, Maximum +15

Tensile Strength, Change Maximum -15%

Elongation at Break, Change, Maximum -40%

Ozone - 1 PPM in Air by Volume 20% Strain

38 ±1 °C [100+/-2 °F] - ASTM D1149*

(*Samples shall be solvent wiped before test
test to remove any traces of surface impurities).

No Cracks
100 hours

Compression Set - 22 Hours/100 °C

[22 Hours/212 °F], ASTM D395

- Method B, 0/0 Maximum 35%

ASTM D746 - Procedure B Brittleness at -40 °C [-40 °F]
No Failure

Fluid Resistance - ASTM D471

70 hrs. at 100 °C [212 °F] in ASTM oil No.3

Change in volume, Max. +120%

Change in tensile strength, max. -70%

Change in ultimate elongation, max. -55%

The finished fabric shall have a minimum breaking strength of 120 N/mm [700 lb/in] when tested by ASTM Test Method D5034. The minimum breaking strength shall be determined on a sample taken transverse to the centerline of the trough.

When delivered to the job site, each separate length, roll or container shall be clearly tagged or marked with the manufacturer's name, trade mark and lot number. A lot is defined as that amount of fabric manufactured at one time from one batch of elastomer. A batch is defined as that amount of elastomer prepared and compounded at one time. The Contractor shall furnish a Materials Certification Letter for each lot in accordance with Section 700 -- Materials.

Not less than thirty days prior to the installation of the trough, a sample length of each lot of fabric, not less than 1 m [3 feet] long, shall be submitted to the Engineer for testing. All samples shall be taken from the lot(s) to be furnished, shall be tagged for identification purposes and shall be furnished to the Engineer free of cost. Approval of the material must be obtained before the material is incorporated in the work.

521.05 Fabrication. Before fabricating any material, the Contractor shall submit drawings to the Engineer for approval in accordance with Subsection 105.02. These drawings shall include, but not be limited to, the following information: The complete details of the method, materials and equipment proposed to be used in the installation operation. Such details shall give complete specifications and details of the elastomeric trough, and other data pertaining to the installation operation.

Installation holes shall be round and cleanly cut with a sharp tool. Holes having jagged or roughly cut edges will be cause for rejection of the trough unit.

521.06 Construction. Where a splice is required for stage construction, the upper section of the trough shall be fitted inside the lower section of the trough in such a manner that any water spillage through the splice shall be eliminated.

521.07 Method of Measurement. Expansion Device - Finger Joint will be measured by each unit, complete in place and accepted. Each unit shall consist of one pair of matching devices including anchorage system, and curb and sidewalk expansion devices as required, and if shown on the plans trough supports, downspouts and chutes.

Fabric trough for finger joint will be measured for payment by each unit complete in place and accepted.

521.08 Basis of Payment. The accepted quantity of Expansion Device - Finger Joint will be paid for at the contract unit price each, which payment shall be full compensation for all materials including anchorage system, curb and sidewalk expansion dams, trough support systems, downspouts and chutes, galvanizing, equipment, labor and incidentals necessary for furnishing and installing the expansion devices and expansion dams. The accepted quantity of fabric trough for finger joint will be paid for at the contract price each, complete in place and accepted, which price shall include all materials, equipment, tools and labor incidentals thereto.

Payment will be made under:

Pay Item	Pay
Unit	
521.23 Expansion Device - Finger Joint	
Each	

521.32 Fabric Trough for Finger Joint
Each

SECTION 522 -- EXPANSION DEVICES -- MODULAR

522.011 Description. This work shall consist of furnishing and installing shop fabricated modular expansion devices. This shall include, but not be limited to, neoprene seal elements, steel transverse dividers and end channels, support bars and bearings, anchorages and sidewalk, median and parapet expansion dams, all as specified herein or detailed on the plans.

522.012 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Stud Anchors	711.06
Structural Steel	713.01
High Strength Bolts	713.02
Steel Extrusions	713.08
Lubricant - Adhesive	714.03
Compression Seals	714.05
Gland Type Seals	714.06

All steel divider bars, end channels and support bars shall be of either ASTM A588/A588M or ASTM A572/A572M Grade 345 [Grade 50] Steel. All other steel shall be ASTM A36/A36M. The entire assembly, unless otherwise indicated on the contract plans, shall be hot dip galvanized in conformance with ASTM A123. All miscellaneous materials such as stainless steel sliding surfaces, bearings, etc. shall be as recommended by the manufacturer, and as approved by the Engineer. The manufacturer shall submit full information on material specifications and dimensional data for approval.

522.013 Design. The modular expansion devices shall incorporate divider bars, end channels, divider bar supports, seals, a system to maintain the seals at a substantially equal spacing at all times, and joint armor incorporating a support system for the divider bar supports and an anchoring system for fixing the expansion device to the supporting concrete. The expansion devices shall be capable of accommodating the movements specified on the design drawings.

The system maintaining the seal spacing shall be subject to prior approval by the Engineer and shall be a design that does not employ a rigid scissors type mechanical system. The seal spacing system shall at all times exert a positive control force, and shall have a certain amount of flexibility to absorb shock loads such as snowplow impacts.

The sealing elements shall be either compression seals or gland type seals, and shall be fabricated with lugs or other protrusions designed to have a positive interlocking action with the divider bars. Sealing elements that are continuous over the full width of the joint, and require a clamping element to fix the sealing element to the top surface of the divider bar(s), will not be accepted. The minimum joint opening between adjacent divider bars shall be 12 mm [$\frac{1}{2}$ inch], and the maximum joint opening shall be 89 mm [$3\frac{1}{2}$ inches].

The divider bars and end channels shall be extruded or rolled shapes, designed to positively interlock with the sealing elements, and capable of sustaining all vertical and horizontal loads imposed by the traffic.

The divider bar supports shall be supported on the joint armor in a manner incorporating sufficient flexibility to absorb vertical shock loads.

The divider bars, divider bar supports and associated bearings, hardware, etc. shall be capable of supporting the loads imposed by the wheels of an MS22.5 [HS25] truck. The manufacturer shall submit computations and data to verify this specified load carrying capacity and said computations shall show conformance to all applicable requirements of the AASHTO Standard Specifications for Highway Bridges, Section I.

522.014 Fabrication. The expansion joints shall be shop assembled in accordance with the manufacturer's recommendations and in conformance with the details shown on the plans and in these specifications.

All welding and fabrication shall be in accordance with the applicable provisions of Section 504.20, Welding. All shop welding shall be completed to the greatest extent possible before the steel is galvanized, and any welds to be made after the steel is galvanized shall be identified on the shop detail drawings. If welded subsequent to the galvanizing of the steel, welded areas shall be power wire-brushed in conformance with SSPC-SP3, or commercial blast cleaned in conformance with SSPC-SP6, and shall be given a 75m [3 mil] coat of either Rustoleum Zinc-Sele 9285 (Gray), Carboline Organic Zinc Phenoxy 676 or an approved equal paint, and any damaged areas of the galvanizing shall be similarly treated.

The galvanizing on the metal surfaces in direct contact with the neoprene seals shall be lightly sandblasted to a dull gray appearance so as to provide a high strength bond between the seal and mating metal surfaces.

Seal elements shall be furnished and shop installed in one continuous length, and splices will not be allowed, except as specified hereafter. Manufacturer's shop splices in compression seals will be allowed, if spaced not less than 15 m [50 feet] apart. Splices in seals will also be allowed at abrupt changes in horizontal alignment. Abutting surfaces of splices shall be vulcanized together or, for compression seals, bonded with adhesive. For abrupt changes in vertical alignment compression seals may be cut over the lower 75 percent of the seal depth.

The Contractor shall submit shop details, erection, and other working drawings in accordance with subsection 504.03. The Contractor shall also give the Engineer ample notice of the beginning of work in the shop, so that inspection may be provided. No work shall be done in the shop before the Engineer has been so notified.

The fabricated expansion device shall be preset by the manufacturer, prior to shipment, to the dimensions for 7 °C [45 °F]. Hardware for leveling, shipping and adjusting the device shall be supplied as part of the assembled expansion device. Final width adjustments of the prefabricated expansion device shall be made at the direction of the Engineer, in the field, prior to the final concrete placement.

522.015 Delivery. Modular expansion devices shall be delivered to the job site in one unit, fully assembled. No field joints will be allowed, unless shown on the design drawings or approved by the Engineer prior to shop fabrication. In no case will field splices be allowed in the sealing elements.

522.016 Installation. Following completion of the structural deck slab, the expansion devices shall be installed in the blocked out portion of the slab and abutment backwall. Following final adjustment, the device shall be permanently fixed in place, all shipping and adjustment devices shall be removed, and concrete shall be placed to complete the deck slab and backwall to the lines and grades shown on the design drawings.

522.017 Method of Measurement. Modular expansion devices to be measured for payment shall be the number of units called for on the plans.

522.018 Basis of Payment. Modular expansion devices, complete in place and accepted, will be paid for at the contract unit price each, which price shall be full compensation for all materials, equipment, labor and incidentals necessary for furnishing and installing the expansion devices in accordance with the plans and these specifications.

Payment will be made under:

Pay Item

Pay Unit

522.06 Modular Expansion Devices

Each

SECTION 523 -- POT BEARINGS

523.01 Description. This work shall consist of designing, furnishing, and installing pot bearings in accordance with this Special Provision, the Standard Specifications, and in reasonable conformity with the configuration and details shown on the plans.

523.02 Materials. Structural steel for the bearings and plates shall conform to the requirements of AASHTO M183/M183M (ASTM A36/A36M) AASHTO M223/M223M (ASTM A572/A572M) or AASHTO M222/M222M (ASTM A588/A588M).

The elastomer shall be either chloroprene or natural polyisoprene of 50 ± 10 Shore A durometer hardness and shall conform to the requirements of Division 2, Subsection 18.3.3 of AASHTO Standard Specifications for Highway and Bridges, where applicable.

The sealing rings shall be brass, and if flat, shall conform to the requirements of ASTM B36, half hard. If round sealing rings are utilized, they shall conform to the requirements of Federal Specification QQB626, Composition 22, half hard.

The TFE shall conform to the requirements of Division 2, Subsection 18.8 of AASHTO Standard Specifications for Highway and Bridges.

Stainless steel shall conform to the requirements of ASTM A240, Type 304 with a hardness between 80 and 90 Rockwell B.

523.03 Design. The pot bearings shall be designed for the loads and movements given on the plans. Configurations and dimensions other than those given on the plans may be accepted subject to the approval of the Engineer.

Except where indicated on the plans, the design shall also include the connections between the bearings and the superstructure and the bearings and the substructure, along with adequate provisions for hold-downs equal to the tensile strength of the anchor bolts.

Shop drawings of the bearings shall be submitted in accordance with Subsection 105.02 of the Standard Specifications. Design calculations of the bearings shall also be submitted to the Engineer for review along with the shop drawing submittal.

The bearings shall be designed to accommodate a rotation of not less than 0.015 radians.

The static coefficient of friction between the polytetrafluoroethylene (TFE) and the stainless steel surface, for each size and type of bearing, shall not exceed 0.04, unless otherwise specified on the plans, at the average unit bearing pressure for the minimum vertical load indicated on the plans.

The bearings shall be designed for a horizontal force at least equal to 10 percent of the vertical capacity of the bearing.

No more than two bearings, with guide bars, per bearing line, shall be considered to be carrying the total maximum lateral horizontal load as indicated on the plans.

Bearing friction shall not be considered when the horizontal load capacity of guided or fixed bearings is calculated.

The elastomeric discs shall be designed to meet the following:

1. The minimum thickness shall be 1/15 of the diameter.
2. The average unit pressure shall be 24.1 MPa [3500 psi], -0 percent, +10 percent, for the maximum vertical load indicated on the plans.
3. The average unit pressure shall not be less than 4.8 MPa [700 psi] for the minimum vertical load indicated on the plans.
4. When utilizing flat brass sealing rings, the upper edge of the discs shall be recessed to receive the brass rings.
5. A TFE sheet, filled or unfilled, 1.6 mm [1/16 inch] minimum thickness and the same diameter as the design diameter of the disc, shall be placed below the discs.

The pot shall be designed to meet the following:

1. The depth of the cavity shall be equal to or greater than: twice the design rotation plus 2.5 mm [0.1 inch] plus the thickness of the elastomeric disc and the TFE sheet.
2. The inside diameter shall be the same as the design diameter of the elastomeric disc.

3. The pot shall be mounted, to provide a tight fit, in a 3 mm [1/8 inch] minimum depth recess in the steel masonry plate or distribution plate and shall be capable of being removed for inspection and repairs.

The piston shall be designed to meet the following:

1. The outside diameter shall be 0.76 mm [0.03 inch] less than the inside diameter of the pot.
2. The minimum thickness shall be not less than 0.08 times the design diameter.
3. When utilizing round brass sealing rings, the lower outside edge shall be beveled to accept and retain the brass ring and to permit full design rotation.
4. Laterally restrained pot bearings shall have a keyway in the sole plate. The top surface of the piston shall have a keyway slot and a cold finished steel guide bar press fitted into it and welded at the ends.
5. A TFE sheet, filled or unfilled, 1.6 mm [1/16 inch] minimum thickness and the same diameter as the bottom surface of the piston, shall be bonded to the bottom surface of the piston.

The elastomer sealing rings shall be brass and shall be designed to meet the following:

1. Flat brass sealing rings, if utilized, shall:
 - a. Have a width of 10 mm [3/8 inch] minimum with bearings up to a 4450 kN [1000 kip] capacity and a 13 mm [1/2 inch] width with bearings over a 4450 kN [1000 kip] capacity.
 - b. Have a minimum thickness of 1.3 mm [.050 inch].
 - c. Have two rings with a bearing capacity up to 4450 kN [1000 kips], three rings with a bearing capacity over 4450 kN [1000 kips], but less than 13 500 kN [3000 kips], and four rings with a bearing capacity of over 13 500 kN [3000 kips].
 - d. Have the ends cut at 45° with a minimum gap in the installed position of 1.27 mm [.050 inch] and shall fit the inside diameter of the pot snugly.
 - e. Have the ring gaps staggered 180° apart.

2. Round brass sealing rings, if utilized, shall:
 - a. Be of one piece with the ends brazed to make a solid ring.
 - b. Have the outside of the ring fit snug in the inside diameter of the pot.

The TFE sliding surface shall be designed to meet the following:

1. The average unit pressure shall be 24.1 MPa [3500 psi], -5 percent, +0 percent, for the maximum vertical load indicated on the plans.
2. Unfilled TFE shall have a minimum thickness of 3.2 mm [1/8 inch] with half of its thickness recessed into the piston.
3. Filled TFE shall be a minimum of 1.6 mm [1/16 inch] thick and shall be bonded to the surface of the piston and to the guide bar.
4. The maximum thickness of the TFE, filled or unfilled, shall be 2.4 mm [3/32 inch], except, if recessed it shall be 4.8 mm [3/16 inch].

The stainless steel sliding surface shall be designed to meet the following:

1. The stainless steel shall cover the TFE in all operating positions such that the stainless steel will have a minimum of 25 mm [1 inch] edge clearance beyond the TFE.
2. The thickness shall be not less than 1.02 mm [.040 inch] nor greater than 2.29 mm [.090 inch].
3. When a center guided key is utilized, a recess shall be machined in the sole plate and the vertical sliding surfaces of the recess shall be covered with stainless steel.

The guide bars shall be designed to meet the following:

1. The guide bars shall be designed for the maximum horizontal load, as indicated on the plans, but not less than 10 percent of the vertical capacity of the bearing.
2. The guided member shall be within the guide bars at all operating positions.
3. The overall width of the guide bar and the TFE sliding surfaces shall be 3.2 mm [1/8 inch] less than the clear width of the keyway in the guided member.
4. A TFE sheet, 1.6 mm [1/16 inch] minimum thickness shall be bonded to the sliding contact surfaces of the guide bars. The sheets shall be filled TFE.

CONSTRUCTION REQUIREMENTS

523.04 Fabrication. Bonding of TFE sheets to the piston shall be under factory controlled conditions and in accordance with written instructions of the manufacturer of the adhesive. After completion of the bonding operation, the TFE surface shall be smooth and free from bubbles. TFE surfaces shall not be polished, but shall be wiped clean using a solvent appropriate for the material.

The stainless steel sliding surfaces shall be seal welded around the entire perimeter. The surfaces shall be smooth and flat and the back shall remain in contact with the sole plate. The surface finish shall be less than 0.25 μ m [10 micro inches] measured as specified in American Standard Specification ANSI B 46.1.

Pots shall be machined from a solid plate or fabricated by welding a flame cut shape to a plate. Fabricated pots shall be 100 percent ultrasonically tested at the inside weld and magnetic particle tested at the exterior weld. The internal finish shall be less than 3.2 μ m [125 micro inches] (ANSI B 46.1).

The elastomeric discs shall be manufactured from no more than three pieces.

Brass sealing rings shall have finished surfaces of less than 1.6 μ m [63 micro inches] (ANSI B 46.1).

The piston and guide bar shall have finished surfaces of less than 3.2 μ m [125 micro inches] (ANSI B 46.1).

METRIC UNITS

Fabrication tolerances of the bearings shall be as follows:

1. Pots - inside diameter - ± 0.125 mm underside flatness - Class "A"
2. Elastomeric Discs - diameters > 500 mm - ± 2.4 mm
diameters 500 mm - ± 1.6 mm
thickness - 0 mm, +3 mm
3. Piston - diameters > 500 mm - ± 0.125 mm
diameters 500 mm - -0.180 mm, +0.125 mm
upper side flatness - Class "A"
under side flatness - Class "B"

4. Masonry and Distribution Plates -
 - plan dimensions > 750 mm - -0 mm, +5 mm
 - plan dimensions 750 mm - -0 mm, +3 mm
 - flatness - Class "B"
5. TFE - plan dimensions - -0 mm, +5%
 - flatness - Class "A"
6. Stainless Steel - flatness - Class "A"
7. Sole Plate -
 - plan dimensions > 750 mm - -0 mm, +2 mm
 - plan dimensions 750 mm - -0 mm, +3 mm
 - thickness - -1 mm, +3 mm upper side flatness - Class "B"
 - minimum beveled edge thickness - 16 mm
8. Guide Bars - Length - ± 3 mm
 - section dimension - ± 2 mm
 - bar to bar - ± 1 mm
 - parallelism - 1 mm
 - bearing side flatness - Class "A"

ENGLISH UNITS

1. Pots - inside diameter - ± 0.005 "
 - underside flatness - Class "A"
2. Elastomeric Discs - diameters > 20" - $\pm 3/32$ "
 - diameters 20" - $\pm 1/16$ "
 - thickness - -0", +1/8"
3. Piston - diameters > 20" - ± 0.005 "
 - diameters 20" - -.007", +.005"
 - upper side flatness - Class "A"
 - under side flatness - Class "B"
4. Masonry and Distribution Plates -
 - plan dimensions > 30" - -0", +3/16"
 - plan dimensions 30" - -0", +1/8"
 - flatness - Class "B"
5. TFE - plan dimensions - -0 mm, +5%
 - flatness - Class "A"

6. Stainless Steel - flatness - Class "A"

7. Sole Plate -

plan dimensions $> 30'' - 0'', +3/32''$

plan dimensions $30'' - 0'', +1/8''$

thickness $- 1/32'', +1/8''$

upper side flatness - Class "B"

minimum beveled edge thickness - $5/8''$

8. Guide Bars - Length - $\pm 1/8''$

section dimension - $\pm 1/16''$

bar to bar - $\pm 1/32''$

parallelism - $1/32''$

bearing side flatness - Class "A"

The flatness of the bearing surfaces shall be determined as follows:

Place a precision straightedge, longer than the nominal dimension to be measured, on the surface to be measured. The plate will be acceptable if a feeler gage, with an accuracy of ± 0.025 mm [± 0.001 inch], will not pass under the straightedge.

The acceptable flatness tolerances for the designated classes are:

Class "A" - .0005 times the nominal dimension.

Class "B" - .001 times the nominal dimension.

The nominal dimension being the actual dimension of the plate under the straightedge.

All structural steel, except surfaces bonded to TFE and stainless steel surfaces, shall be zinc metalized in accordance with AWS C2.2 with a dry coating thickness of 0.20 mm [8 mils] on exterior surfaces and 0.05 mm [2 mils] on interior surfaces.

Each bearing shall be assembled at the plant and following assembly, shall be sealed at the joint between the piston and the pot with a continuous 6 mm [$1/4$ inch] bead of a flexible silicone rubber sealing compound approved by the Engineer.

Each bearing shall have permanent match marks to indicate the neutral 7°C [45°F] position of the bearing. Each bearing shall also be marked for identification by die-stamping on all steel parts (edge of sole plate, piston, masonry plate, and top edge of pot).

Each bearing shall be shipped and stored in moisture- proof and dust-proof covers until such time as they are to be erected.

The Contractor shall notify the Engineer at least 10 days in advance of the start of fabrication so that inspection of the work can be provided by the Department.

523.05 Testing and Certification. The manufacturer of the pot bearings shall furnish test facilities for testing and inspection of the completed bearings in his plant or at an independent test facility approved by the Engineer. The Engineer or his authorized representative shall be allowed free access to the manufacturer's plant and test facility. The Engineer will select two completed bearings for testing. The test shall be arranged so that the static coefficient of friction on the first movement can be determined. The test shall first be conducted at an average bearing pressure of 24 MPa [3500 psi] on the TFE surface with the test load applied continuously for not less than 12 hours nor more than 14 hours prior to measuring the friction. The first movement static coefficient of friction shall then be determined. The above test shall then be repeated for the minimum vertical load indicated on the plans for the bearings selected. The results shall not exceed that specified for the design.

A proof load test shall also be performed on each test bearing by applying a load equal to 150 percent of the maximum vertical load indicated on the plans for the bearings selected for a period of one hour. The test bearings shall show no sign of failure or other defects while under load or subsequently upon disassembly and inspection.

Prior to testing, the testing equipment and procedure shall be approved by the Engineer.

523.06 Installation. When the bearings are to be set directly on the concrete bridge seats, as indicated on the plans, the bridge seats shall be dressed 25 mm [1 inch] larger all around than the masonry plates and to the exact elevations shown on the plans or as determined by the Engineer. If dressed areas are lower than the surface of the surrounding bridge seat, a small channel shall be cut to the edge of the bridge seat for drainage.

Masonry plates shall be set level in their exact position and shall have a full and even bearing upon the masonry. They shall be placed on a preformed pad, the same size and shape as the masonry plate with holes to match the masonry plate. The Contractor shall drill the holes and set the anchor bolts. The bolts shall be accurately set with an approved two part high- strength epoxy mortar. The epoxy mortar shall completely fill the holes.

When the bearings are to be set on a grout pad, the grout shall be composed of one part of Portland Cement, Type I or II, to two parts fine aggregate by weight with nonshrink admixture, approved by the Engineer, well mixed with sufficient water to produce proper consistency.

The grout shall have a minimum compressive strength of 27.5 MPa [4000 psi] at 28 days. A sufficient quantity of the grout materials, including admixtures, and the design composition shall be submitted to the Engineer for testing 60 days prior to placement.

The grout shall be well bonded to the adjacent concrete and shall be placed under pressure to ensure that all anchor holes and the entire area under the masonry plate is free of voids.

The sliding surfaces of bearings shall be installed level. Special care shall be exercised at all times to ensure protection of the stainless steel and the TFE surfaces from coming in contact with any foreign matter.

At no time shall any forms, debris, or other material interfere with the free action of the bearing assemblies.

523.07 Method of Measurement. Pot bearings will be measured for payment by each unit, complete in place and accepted.

523.08 Basis of Payment. Pot bearings will be paid for at the contract unit price each, which price shall be full compensation for the design, fabrication, delivery, and installation, including all materials, equipment, labor and incidentals necessary for furnishing and installing the bearings in accordance with the plans and this Special Provision.

Payment will be made under:

Pay Item

Pay Unit

523.10 Pot Bearings

Each

SECTION 524 -- TEMPORARY STRUCTURAL SUPPORTS

524.01 Description. This work shall consist of the designing, fabricating, erecting, maintaining, and dismantling of temporary structural support(s) as called for on the contract plans, all in conformity with these specifications. Temporary structural supports proposed by the Contractor to facilitate the work shall also conform to these specifications.

524.02 Materials. Materials used may be either sawn timber or steel, or a combination of both, at the Contractor's option, and, whether new or used, shall be sound and of adequate cross section for the intended loads. Blocking needed below the temporary supports to accommodate differences in elevation, and/or pads required to distribute loads to the soil may additionally incorporate plain and reinforced concrete.

524.03 Design. Temporary structural support(s) shall be designed to support all vertical loading including live load and impact, differential settlement forces, horizontal and longitudinal forces, and shall account for any temporary unbalanced loading due to jacking forces and other

loading during load transfer. Sufficient redundancy shall be designed into the support structure so that failure of one member will not cause the collapse of the entire system and the supported structure. Temporary support(s) shall be designed by a registered Professional Engineer and all plans, computations, and working drawings shall be signed by that Engineer, and shall be submitted to the Engineer for approval.

Temporary supports which are adjacent to traveled ways or which support structures carrying traffic shall additionally be designed to resist any vibration or impact forces due to traffic and shall incorporate sufficient protection against impact by errant vehicles.

524.04 Erection and Removal. The erection of temporary support(s) shall be in strict conformance with the approved design and details and shall use only the materials approved for use. No loads shall be placed on the temporary support(s) without the prior approval of the Engineer.

No loads shall be placed on temporary supports which are adjacent to travelled ways or which support structures carrying traffic unless the Engineer responsible for the design has certified to the Engineer that the system was erected in conformance with the approved plans and design details.

The approval by the Engineer of all or part of temporary support(s) shall not be construed as in any way relieving the Contractor of his responsibility and the work shall be entirely at the Contractor's risk.

Upon completing the work requiring the use of the temporary structural supports, they shall be removed and the area under and around the temporary structural supports shall be restored to is original condition.

524.28 Method of Measurement. Temporary structural supports will be measured as the number of individual units called for on the plans, satisfactorily designed, erected and dismantled. Temporary supports used by the Contractor for his convenience will not be measured for payment. The removal and reinstallation of existing highway appurtenances (e.g. guardrails, sign supports, etc.) to facilitate the erection of temporary supports will not be measured for payment, but will be considered incidental to the work under this specification.

524.29 Basis of Payment. Temporary structural supports will be paid for at the contract unit price each which price shall be full compensation for all materials, equipment, labor and incidentals necessary for the design, erection, maintenance, and dismantling of such supports in accordance with these specifications.

Pay Item	Pay Unit
524.30 Temporary Structural Support	Each

SECTION 525 -- GRANITE MASONRY

525.01 Description. This work shall consist of furnishing and placing granite pier facing in accordance with these specifications and as shown on the plans.

MATERIALS

525.02 Materials. The granite shall be obtained from an approved quarry and be free from materials which, by weathering, would cause discoloration or deterioration. The granite for the entire job shall be uniform in color and free from seams, cracks and other structural defects.

Caulking of joints shall be accomplished with a two component, epoxy-resin system designed for the intended use. A quartzite aggregate shall be added in accordance with the manufacturer's recommendations. The material shall be moisture insensitive, of low modulus of elasticity, and of a gel-like non-sag viscosity. Color shall be gray. The materials shall be subject to the approval of the Engineer.

Anchors shall be of either ASTM A36/A36M galvanized steel or stainless steel, 20 mm [$\frac{3}{4}$ inch] diameter, as indicated on the plans. Other types of anchors may be used with prior approval of the Engineer.

Joint mortar shall comply with Subsection 705.02, except it shall contain an approved additive to insure water-tightness. The additive shall not contain a retarding agent or hydrated lime.

CONSTRUCTION REQUIREMENTS

525.03 General. Granite masonry shall have all stones dressed and cut to exact dimensions and laid up in joint mortar, with joints 10 mm $\pm$ 3 mm [$\frac{1}{2}$ inch $\pm$ inch] thickness.

A complete setting plan shall be submitted for approval prior to ordering any stone.

The arrangement and the length of the stones shall be as approved by the Engineer.

525.04 Stones. The finish on exposed surfaces of the stones shall be free from tool marks. Irregular projections shall be limited to a maximum of 75 mm [3 inches] for any one stone

measured from the pitch line. Irregular depressions shall be limited to a maximum of 25 mm [1 inch] for any one stone measured from the pitch line.

Stones shall have their edges pitched to a true line with tops and bottom parallel and cut to lie on their natural beds. The top and bottom beds shall be the full size of the stone, and hollow beds shall not be permitted. The beds of stone shall be sawn or fine finished, full depth. The vertical face joints shall be sawn or fine finished for a depth of not less than 100 mm [4 inches], with the balance not to fall away more than 100 mm [4 inches].

The top layer of granite shall have a 40 mm [1½ inch] wide chisel draft line along the top face adjacent to concrete.

All stones shall be so finished that no holes or portions of holes shall show on surfaces which will be exposed in the finished work.

The depth of the stone shall be not less than 200 mm [8 inches] and not more than 300 mm [12 inches] measured from the back face of the stone to the pitch line. The Contractor shall use extreme care when placing the concrete within the boundaries of the stone facing to avoid causing air pockets due to overhanging stones. Stone heights shall be a minimum of 375 mm [15 inches].

525.05 Anchors. Holes for anchors shall be drilled in the stones before they are placed.

There shall be a minimum of 2 anchors at a maximum spacing of 1200 mm [4 feet] in the top and bottom beds of each piece and grooves shall be cut from the anchor holes to the back of the stones.

Stones greater than 1200 mm [48 inches] in height shall have additional anchors located in the back face of the pieces such that there will be a maximum spacing, both vertical and horizontal, of 1200 mm [4 feet] between anchors.

Anchors in the top and bottom beds of each stone shall be located such that an anchor will be not greater than 450 mm [18 inches] from each end of the piece. Anchors in the back face of each stone shall be located such that an anchor will be not greater than 450 mm [18 inches] from each end of the piece.

525.06 Mortar. Joint mortar shall be machine mixed for not less than 1½ minutes after all ingredients are in the mixer. Mortar shall be used within 45 minutes after mixing and the retempering of mortar will not be permitted.

525.07 Setting Stones. Stones shall be thoroughly cleaned before being set, and the bed to receive it shall be well cleaned. The thickness of all joints and beds shall be uniform throughout. Spalls shall not be used as pinnars in mortar beds or joints. When any stone is disturbed or mortar joint broken, the stone shall be taken up, and after all mortar has been cleaned from the stone, bed

and joints, the stone shall be reset in fresh mortar. All stones shall be well bedded with the face joints properly raked before the mortar has set.

The masonry shall be kept wet during the pointing, and in hot or dry weather shall be protected from the sun and kept wet for a period of 3 days after completion, unless otherwise permitted or directed. Face surfaces of stone shall not be smeared with mortar and after pointing has been completed and set, the masonry shall be thoroughly cleaned as directed. Stone shall not be set when the stones contain frost or during freezing weather unless permitted.

Concrete backing shall be of the class shown on the plans. The concrete shall be so worked and compacted that all spaces around stones are completely filled and an adequate bond with the stone is secured. Construction joints in the concrete, required by intermittent placing, shall be located not less than 150 mm [6 inches] below the top bed of any course of the stone facing. The stones shall be secured and the concrete so placed, as approved by the Engineer, to prevent movement of the stones during placement of the concrete.

525.08 Joints. All joints shall be raked 40 mm [1½ inches] deep and caulked with an approved two component epoxy resin system. All caulking shall be done in such a manner to produce a tight, durable and impervious seal at all joints. All caulking shall be accomplished as soon as possible to avoid exposure at joints to salt water.

The two component epoxy resin system shall be proportioned, mixed, and applied in accordance with the manufacturer's recommendations.

The joint below the bottom layer of granite shall be 25 mm ± 10 mm [1 inch ±½ inch] in thickness. Lead wool caulking of this bottom joint will not be required.

525.09 Method of Measurement. Granite masonry will be measured for payment by the number of square meters [square feet] of exposed granite masonry, including joints, in the completed work and measured from the pitch lines as shown on the plans.

525.10 Basis of Payment. Granite masonry will be paid for at the contract unit price per square meter [square foot] complete in place and accepted. This price shall include all materials, labor and incidentals necessary to complete the work. The cost of the anchors, completed and in place, shall be included in the contract unit price of this item.

Payment will be made under:

Pay Item

Pay Unit

525.30 Granite Masonry
Foot]

square meter [Square

SECTION 526 -- CONCRETE BARRIER

526.01 Description. This work shall consist of the setting, resetting and removing of temporary concrete barrier and elements in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or as established.

Temporary Concrete Barrier, Type I shall consist of a double faced barrier of a shape designated on the plans with attachments that allow sections to be connected into a continuous barrier. The connections shall be of a type which allows disassembly, moving and reassembly of the barrier. Provisions shall be made in the casting of the barrier for attaching the barrier to the roadway and to bridge decks, when such attachment is specified on the plans.

MATERIALS

526.02 Materials. Concrete shall be portland cement concrete. The State reserves the right to take test core samples from the barriers in accordance with ASTM C42. Average compressive test strengths below 17 MPa [2,500 psi] will result in rejection of the barriers.

Reinforcing steel shall meet the requirements of ASTM A615/A615M, Grade 400 [Grade 60].

CONSTRUCTION REQUIREMENTS

526.03 General. Temporary concrete barrier shall generally be free of fins and porous areas and shall present a neat and uniform appearance.

Permissible dimensional tolerances for temporary concrete barrier shall be as follows:

- (a) Cross sectional dimensions shall not vary from design dimensions by more than 6 mm [$\frac{1}{4}$ inch]. The vertical centerline shall not be out of plumb by more than 6 mm [$\frac{1}{4}$ inch].
- (b) Longitudinal dimensions shall not vary from the design dimensions by more than 6 mm per 3 m [$\frac{1}{4}$ inch per 10 feet] of barrier section and shall not exceed 20 mm [$\frac{3}{4}$ inch] per section.
- (c) Location of anchoring holes shall not vary by more than 13 mm [$\frac{1}{2}$ inch] from the dimensions shown in the concrete barrier details on the plans.

(d) Surface straightness shall not vary more than 6 mm [1/4 inch] under a 3 m [10 foot] straightedge.

The barrier shall have no significant cracking. Significant cracking is defined as fractures or cracks passing through the section or any continuous crack extending for a length of 300 mm [12 inches] or more, regardless of position in the section.

526.04 Installation. Temporary concrete barrier shall be placed, relocated and removed as shown on the plans or as directed.

Temporary concrete barriers which have been damaged, by other than the traveling public while in use or show signs of deterioration shall be replaced, as directed, at no additional cost to the State.

526.05 Method of Measurement. Temporary concrete barrier will be measured for payment by the meter [linear foot] from end to end of each run of barrier measured along the centerline of the barrier complete in place or by the lump sum unit as specified. No deduction in pay length will be made for joints between abutting barrier sections.

When measured for payment by the lump sum unit is specified, measurement will consist of the installation and removal of all the concrete barrier required by the plans for the Contractor's operations.

Barrier reinforcing steel, cable and fixtures will not be measured separately for payment and payment will be considered included in the unit bid price for temporary concrete barrier.

Sections of temporary concrete barrier damaged by the traveling public shall be replaced by the Contractor, when directed by the Engineer and will be measured for payment.

526.06 Basis of Payment. The accepted quantities of temporary concrete barrier, Type I, will be paid for at the contract unit price per meter [linear foot] or lump sum, as specified, complete in place. Such payment shall be full compensation for furnishing all material, assembling and all incidentals necessary to complete the work.

When paid for at the contract lump sum price, such payment shall be full compensation for furnishing all materials, assembling, moving and resetting, transporting, temporary storing, removing furnishing new parts as necessary, and all incidentals necessary to complete the work.

Payment for resetting temporary concrete barrier shall be full compensation for removing, transporting, temporary storing, resetting and furnishing new parts when necessary. No additional payment will be made for temporary concrete barrier removed and not reset. The temporary barrier shall become the property of the Contractor upon completion of the use of the barrier on the project and shall be removed from the project site by the Contractor.

Payment will be made under:

Pay Item	Pay Unit
526.30 Temporary Concrete Barrier Type I [Linear Foot]	meter
526.301 Temporary Concrete Barrier Type I Lump Sum	
526.40 Resetting Temporary Concrete Barrier Type I [Linear Foot]	meter

SECTION 527 -- ENERGY ABSORBING UNIT

Reserved

SECTION 528 -- STRUCTURAL TIMBER

Reserved

SECTION 529 -- NAVIGATIONAL AIDS

Reserved

SECTIONS 531-534 -- VACANT

SECTION 535 -- PRECAST PRESTRESSED CONCRETE SUPERSTRUCTURE

535.01 Description. This work shall consist of furnishing, casting and erecting pretensioned bonded prestressed structural concrete units and other related materials in accordance with the plans and specifications.

MATERIALS

535.02 Materials. Materials for precast and/or prestressed structural concrete shall meet the requirements specified in the following subsections.

Water	701.02
Air Entraining Admixture	701.03
Water Reducing Admixture	701.04
Water Reducing, High Range Admixture	701.0401
Calcium Nitrite Solution	701.11
Fine Aggregate for Concrete	703.01
Coarse Aggregate for Concrete	703.02
Reinforcing Steel	709.01

Portland cement shall conform to the requirements of AASHTO M85 Designation for Type I, Type II, or Type III. A combination of any two of these types may be used with the approval of the Engineer.

The brand of cement used in the precast or prestressed units may be different from that used for cast-in-place concrete.

The Contractor shall supply to the Department, without charge, certified copies of the mill tests of all cement supplied, prior to any fabrication. Chemical and physical properties shall meet the requirements of AASHTO M85.

The mill tests shall show the name of the manufacturer, the location where produced, the silo number and the person or agency making the test.

Coarse aggregate shall conform to the gradation requirements for Class AA, or, the following table.

METRIC UNITS

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
19 mm	100
12.5 mm	90-100
9.5 mm	40-70
4.75 mm	0-15
2.36 mm	0-5
75m	1.5 maximum

ENGLISH UNITS

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves

3/4 inch	100
1/2 inch	90-100
3/8 inch	40-70
No. 4	0-15
No. 8	0-5
No. 200	1.5 maximum

535.03 Prestressing Steel. Prestressing steel shall be an uncoated, stress relieved, seven wire strand, conforming to the requirements of ASTM, Designation A416. The strand shall be Grade 270 and shall have a nominal diameter of 12.70 mm [1/2 inches].

A design using Grade 250 strand and a nominal diameter of either 12.70 mm [1/2 inch], or 11.11 mm [7/16 inch] may be submitted by the Contractor for approval by the Engineer.

A Materials Certification Letter will be required in accordance with Division 700.

Each reel of strand shall be clearly labeled or marked by the manufacturer and such identification shall not be removed from the reel or strand until the reel is entirely used or until slab fabrication has been completed.

535.04 Drawings. The Contractor shall prepare shop detail, erection and any other necessary working drawings in accordance with the requirements of Subsection 105.02.

Substitutions of sections, materials or details, differing from those shown on the contract plans or on previously approved drawings prepared by the Contractor, shall be made only when approved by the Engineer.

All changes and revisions to the approved working drawings shall be subject to further approval by the Engineer in accordance with Subsection 105.02.

Preferred plan dimensions shall be 841 mm [36 inches] in length by 594 mm [22 inches] in width, with a border line located 15 mm [1/2 inch] inside the edge on the top, bottom and right end of the plans and 71 mm [2 inches] from the edge on the left end, and shall show the State's project number in the title block. Alternate plan dimensions may be used provided the plan width does not exceed 594 mm [24 inches].

535.05 Rejections. The acceptance of any material or finished units by the Inspector will not prevent their subsequent rejection, if found defective at any time prior to final acceptance of the project. Rejected material and workmanship shall be replaced promptly or made good by the Contractor at no expense to the Department.

CONSTRUCTION REQUIREMENTS

535.06 through 535.09 Vacant

535.10 Methods and Equipment. Before starting the work of erection, the Contractor shall inform the Engineer in writing, as to the method of erection he proposes to follow, and the amount and character of equipment he proposes to use, 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 his method or equipment, or from carrying out the work in full accordance with the plans and specifications. No work shall be done until such approval by the Engineer has been obtained.

535.11 Plant. The prestressing plant shall be approved by the Engineer. The Contractor shall be able to show satisfactory proof to the Engineer that the fabricator has produced prestressed and precast units of consistent high quality as a major product for the last five continuous years.

In lieu of this qualification, the Contractor shall be required to show proof, satisfactory to the Engineer, that the work shall be supervised by technicians having at least 5 years of continuous experience in the manufacture of prestressed and precast units.

535.12 Supervision. The Contractor shall provide a superintendent, in charge of fabrication, who shall directly supervise the work at all times in accordance with Subsection 105.05.

535.13 Concrete. Class P concrete for prestressed structural concrete shall be controlled, mixed, and handled as specified in Section 502 -- Structural Concrete, except as stated herein.

All concrete shall be placed in the presence of a State Inspector. Complete and accurate records of concrete placing and testing operations shall be kept and submitted to the Engineer by the Contractor.

535.14 Vibration. The concrete shall be vibrated internally or externally, or both, to produce a dense, well-compacted concrete.

Internal vibration shall be accomplished with equipment and in a manner consistent with Subsection 502.11. The vibrator heads shall be smaller than the minimum distance between prestressing steel.

535.15 Finish. The top surfaces of the deck units shall have a float finish in accordance with Subsection 502.14. The surface shall be finished to a tolerance of 6 mm [$\frac{1}{4}$ inch] under a 3 m [10 foot] straightedge. Hand operated, vibrating screeds may be used to finish the structural concrete slab. The top surfaces shall be intentionally roughened, except where a separate concrete wearing surface is called for.

The finished product shall have a workmanlike appearance. Acceptable defects and tie holes shall be repaired in accordance with Subsection 502.13.

535.16 Process Control Test Cylinders. A minimum of 12 concrete test cylinders shall be cast to represent each continuous concrete placement or for every 40 m³ [50 cubic yards] of concrete when a continuous placement exceeds 40 m³ [50 cubic yards]. Nine of the cylinders shall be manipulated and cured in the same manner as that in the prestressed units. Slab identification, air content, water cement ratio, slump and temperature of the sampled concrete shall be recorded at the time of cylinder casting.

Adequate personnel shall be provided by the Contractor such that sampled concrete may be tested and specimens molded within 15 minutes after the sample is taken. The Engineer will designate the portion or portions of the concrete batches that are to be sampled.

The cylinders shall be cast and tested at the site of work by the Contractor in the presence of a State Inspector. The cylinder strength of the concrete at any period shall be determined by averaging the compressive strength of a set consisting of at least 3 cylinders tested at the same time.

The testing machine used for compressive strength tests shall be subject to approval by the Engineer. Calibration of the machine shall be made in accordance with AASHTO T67 if deemed necessary by the Engineer.

Testing shall be in accordance with the following specifications:

Making and curing Concrete Compression Test Specimens AASHTO T23

Slump of Portland Cement Concrete AASHTO T119

Sampling Fresh Concrete AASHTO T141

Air Content of Freshly Mixed Concrete by Pressure Method AASHTO T152

Compressive Strength of Molded Concrete Cylinders AASHTO T22

535.17 Curing. Immediately after the concrete in the prestressed units has been placed and consolidated, all exposed surfaces shall be protected from surface drying. The air surrounding the units shall be maintained at a temperature above 10 °C [50 °F]. This initial curing phase shall extend over a period of not less than 3 hours nor more than 5 hours.

After the initial curing phase is completed, the unit shall be kept at 21 to 27 °C [70 to 80 °F] and the exposed concrete surfaces kept moist until the final curing phase is started in accordance with one of the following methods:

- (a) Water Curing. The units shall be maintained on the casting bed in an approved enclosure, designed to keep the units continuously wet and at a controlled temperature. The curing may be accomplished with the use of a continuous fine

spray of water if the concrete is sufficiently hardened to resist damage. The temperature within the enclosure and that of any water used shall be controlled to provide a uniform curing temperature of the units within the limits of 27 to 54 °C [80 to 130 °F] until the required release strength is attained. Changes in ambient air temperature surrounding the units shall not exceed those as specified under paragraph (b).

- (b) **Steam Curing.** The units shall be maintained on the casting bed in an approved enclosure, designed to insure full circulation of thoroughly saturated steam around the units with a minimum of moisture and heat losses. The initial application of steam shall not begin before the initial curing stage has been completed and in no case before all the concrete in the enclosure has attained initial set. The steam shall be fully saturated to provide excess moisture for proper hydration of the cement. Steam shall not be directly applied to the concrete, forms or test cylinders. The exposed surfaces of the concrete shall be kept moist during the entire curing period by application of water if necessary. The water so used shall be at a temperature of not more than 6 °C [10 °F] above or below that of the concrete.

During application of the steam, the ambient air temperature shall increase at a rate not to exceed 22 °C [40 °F] per hour. The maximum temperature within the enclosure shall not exceed 71 °C [160 °F]. In discontinuing the steam, the ambient air temperature shall not decrease at a rate in excess of 20 °C [40 °F] per hour until a temperature has been reached about 10 °C [20 °F] above the temperature of the air to which the concrete will be exposed.

535.18 Completion of Curing. After the units have been detensioned, curing shall continue, by a method approved by the Engineer, until the design compressive strength has been attained. Preference shall be given to water curing and the units shall be kept at a temperature above 10 °C [50 °F].

535.19 Control of Curing Temperature. Regardless of the curing method, the curing temperature throughout the enclosure shall be controlled so that the temperature at the surfaces of the unit is uniformly maintained within plus or minus 5 °C [10 °F].

The Contractor shall provide a continuous record of curing temperatures for the entire curing period by a method meeting the approval of the Engineer. Temperatures shall be taken at least at one location adjacent to each unit being cured at one time in the enclosures so as to maintain a record throughout the entire length of the enclosure. One continuous recording thermometer shall be installed at a representative location in the enclosure for each 60 m [200 feet] of product or each separate casting operation if less than 60 m [200 feet].

535.20 Forms and Casting Beds. Forms and casting beds shall be subject to the approval of the Engineer. In general, only steel forms shall be used for standard members. Inside forms or

void tubes may be of treated cardboard, plywood or other material approved by the Engineer. Post-tensioning ducts shall be of polyvinylchloride, epoxy coated metal or galvanized metal.

The casting beds, form work, reinforcing and hardware shall be approved prior to each time concrete is to be placed therein, but such approval shall not relieve the Contractor of responsibility for the results obtained.

All forms shall be cleaned before each use. New forms shall be free from paint or other protective substances.

Forms shall be well constructed, carefully aligned, substantial and firm, securely braced and fastened together, sufficiently tight to prevent leakage of mortar and strong enough to withstand the method of vibration to be used. Forms shall be so designed that they will not restrict the longitudinal movement of the casting when the prestressing force is transferred to the casting.

Any member with a void out of position in excess of the specified tolerance may be rejected. Void forms shall be anchored firmly and shall be capped at both ends and shall be vented by a method approved by the Engineer.

Forms shall be treated with a non-staining bond breaking substance. Special care shall be exercised to prevent bond breaking substances from coming into contact with reinforcing steel and pretensioning steel. In the event steel has been contaminated with the bond breaking substance the steel shall be replaced or satisfactorily cleaned with a solvent.

Form ties, if used, shall be the threaded type or the snap-off type, but in either case they shall be removed to a depth of not less than 25 mm [1 inch] from the face of concrete without damaging such surfaces.

535.21 Tensioning. Prestressing strands shall be free of deleterious materials and rust. Strands that show any rust pitting whatsoever or strands having kinks, bends, knicks or other defects shall not be used. Splicing of strand will not be allowed. Failure of one wire in a seven wire pretensioned strand will be cause for replacement of the strand.

Prestressing strands shall be tensioned by single or multiple strand methods. In either method, the stress induced in the prestressing steel shall be measured both by gauges and by elongations of the strand. Load-elongation curves pertinent to the reel of strand to be used shall be supplied to the Engineer on request. When a difference of over 5 percent exists between steel stress determined from the correct elongation and from corresponding gauge reading, stressing operation shall cease until the discrepancy is determined and corrected.

The tensioning system shall be equipped with accurately calibrated gauges for registering the loads produced. The gauges shall have a reading accuracy within 2 percent. Pressure gauges shall have a full-pressure capacity of approximately twice the working pressure and the loads to

be gauged shall be not less than one quarter nor more than three-quarters of the total graduated capacity of the gauge.

The gauging devices shall be calibrated by an independent testing laboratory, acceptable to the Engineer, to standard weights and measures meeting the requirements of the National Institute of Standards and Technology. Calibration shall be certified within 3 months prior to the work. The certified calibration curve shall be made available to the Engineer. If during the progress of the work, any gauging system appears to be giving erratic results, or if gauge readings and elongation measurements indicate materially different stresses, the jack and the gauges shall be recalibrated and a new certified calibration curve established.

A minimum initial tensioning force of 4500 N [1,000 pounds] will be allowed to take up any slack and to equalize stresses in the strand. The same jack which is used for single strand tensioning may be used for initial tensioning provided it is equipped with a proper gauging system for the initial tension force.

Before each tensioning operation, the Contractor shall submit to the Engineer the following data:

- (a) Identification of all strands to be tensioned.
- (b) The desired tension on each strand.
- (c) The theoretical elongation.
- (d) Adjusted elongation (allowing for losses).
- (e) The theoretical gauge reading.
- (f) Allowable deviation in gauge reading.

Strands shall be tensioned in the sequence shown on the approved working drawings. Complete and accurate records of each tensioning operation shall be kept and submitted to the Engineer by the Contractor.

All tensioning operations shall be carried out in the presence of a State Inspector.

535.22 Detensioning. Detensioning shall not commence until the concrete has reached at least 27.6 MPa [4000 psi]. Forms or any device which may restrict either horizontal or vertical movement of the units shall be stripped or loosened, prior to detensioning.

Detensioning shall be kept symmetrical about the axes of the unit and in a sequence shown on the approved working drawings. Failure to follow this sequence may be cause for rejection of any units involved, whether or not visible damage has occurred.

Detensioning shall be done as soon as possible in accordance with the specifications. The detensioning shall be done while the concrete is still warm and moist.

If detensioning is accomplished by single strand release, each strand shall be cut by heating gradually with a low oxygen flame at both ends of the prestressing bed simultaneously. A minimum length of 125 mm [5 inches] of strand shall be heated to prevent any shock or snap when the strand is finally severed. Each strand shall also be cut at all spaces between units before starting detensioning on the following strand in the sequence. If the distance between units is sufficiently short, these intermediate points may be cut after all strands at the ends of the bed have been released, with the approval of the Engineer.

If detensioning is accomplished by multiple strand release, the equipment shall be capable of releasing the load gradually, without shock, and with a minimum of movement of the units on the beds. The equipment shall be approved by the Engineer.

After detensioning, each strand shall be finally burned or cut off at a depth of 13 mm [$\frac{1}{2}$ inch] into the end of the unit and the recessed area around the strand shall be filled with 1:2 cement mortar.

All detensioning operations shall be carried out in the presence of a State Inspector.

Precast, prestressed slabs shall be manufactured in conformity with the following tolerances:

Depth of Slab ± 6 mm	$[\pm \frac{1}{4}$ inch]
Width of Slab ± 6 mm	$[\pm \frac{1}{4}$ inch]
Length of Slab ± 3 mm per 3 m	$[\pm$ inch per 10 feet], or 13 mm [$\frac{1}{2}$ inch] whichever is greater
Skewed Ends ± 6 mm	$[\pm \frac{1}{4}$ inch] (Deviation from required skew)
Beam Seat Bearing Area	± 2 mm $[\pm \frac{1}{16}$ inch]
Horizontal Alignment	± 6 mm $[\frac{1}{4}$ inch] (Deviation from straight line parallel to centerline of member)
Dowel Tubes ± 6 mm	$[\pm \frac{1}{4}$ inch] (Center of tube to sides and end of member)
Void Tubes ± 6 mm	$[\pm \frac{1}{4}$ inch] (Vertically & horizontally)
± 13 mm	$[\pm \frac{1}{2}$ inch] (Location of ends)
Post Tension Ducts ± 6 mm	$[\pm \frac{1}{4}$ inch]
Total Width of Deck Camber	± 13 mm $[\pm \frac{1}{2}$ inch]
Differential between Adjacent Units	± 3 mm per 3 m [$\pm$ inch per 10 feet] of length, or 13 mm [$\frac{1}{2}$ inches] maximum
Center of Gravity of Strand Group	6 mm $[\frac{1}{4}$ inch]
Stirrup Bars	13 mm $[\pm \frac{1}{2}$ inch] (Projection above top of beam) 25 mm $[\pm 1$ inch] (Longitudinal spacing)

Precast, prestressed I-girders shall be manufactured in conformity with the following tolerances:

Length	±19 mm [$\pm\frac{3}{4}$ inch]
Width (flanges and fillets)	+10 mm - 6 mm [$\pm$ inch, - $\frac{1}{4}$ inch]
Depth (overall)	+13 mm - 6 mm [$\pm\frac{1}{2}$ inch, - $\frac{1}{4}$ inch]
Width (web)	+10 mm - 6 mm [$\pm$ inch, - $\frac{1}{4}$ inch]
Depth (flanges and fillets)	6 mm [$\frac{1}{4}$ inch]
Horizontal Alignment (deviation from straight line parallel to centerline of member)	±3 mm per 3 m [inch per 10 feet] or 25 mm [1 inch] maximum
Side inserts (center-center and center-end)	±13 mm [$\pm\frac{1}{2}$ inch]
Location of PVC Tubes at bearings (center of tube to end of girder)	±6 mm [$\pm\frac{1}{4}$ inch]
Location of PVC Tubes at bearings (center to center of tubes)	±6 mm [$\pm\frac{1}{4}$ inch]
Location of PVC Tubes @ bearings (from plumb)	±6 mm [$\pm\frac{1}{4}$ inch]
Camber Differential between adjacent units	3 mm per 3 m [inch per 10 feet], 13 mm [$\frac{1}{2}$ inch] maximum
Stirrup bars projection above top of girder	±13 mm [$\pm\frac{1}{2}$ inch]
Stirrup bars (spacing center-center)	±25 mm [± 1 inch]
Tendon Position (c.g. Of strand group and individual tendon)	±6 mm [$\pm\frac{1}{4}$ inch]
Position of deflection points for deflected strands	±150 mm [± 6 inches]
Position of handling devices	±150 mm [± 6 inches]
Exposed girder ends (deviation from square or designated skew)- Horizontal Vertical	±6 mm [$+\frac{1}{4}$ inch] ±3 mm per 300 mm [$\pm$ inch per foot] of girder depth
Bearing Area (deviation from plane on either girder or seat)	±2 mm [$\pm\frac{1}{16}$ inch]

Precast, prestressed box beams shall be manufactured in conformity with the following tolerances:

Length of Unit	±19 mm [$\pm\frac{3}{4}$ inch]
Width of Unit	± 6 mm [$\pm\frac{1}{4}$ inch]
Depth of Unit	± 6 mm [$\pm\frac{1}{4}$ inch]
Width (web)	±10 mm [$\pm$ inch]
Depth (top slab)	±13 mm [$\pm\frac{1}{2}$ inch]
Depth (bottom slab)	+13 mm [$\pm\frac{1}{2}$ inch], - 3 mm [- inch]
Horizontal alignment	10 mm [$\frac{3}{8}$ inch] (Deviation from straight line parallel to centerline of member)
Camber	±13 mm [$\pm\frac{1}{2}$ inch] (Deviation from design camber)

Camber	±19 mm [$\frac{3}{4}$ inch] (Differential between adjacent units)
Position of tendons	±6 mm [$\pm\frac{1}{4}$ inch]
Position of stirrup bars	±25 mm [± 1 inch]
Void dimensions	±13 mm [$\pm\frac{1}{2}$ inch]
	±25 mm [± 1 inch] (adjacent to end block)
Square ends	±13 mm [$\pm\frac{1}{2}$ inch] (deviation from square)
Beam seat bearing area	±3 mm [$\pm\frac{1}{8}$ inch]
Tie rod tubes	±13 mm [$\pm\frac{1}{2}$ inch]

535.221 Stripping. The minimum stripping strength of precast products shall be 17 MPa [2500 psi]

535.23 Transportation and Storage. After the prestressed units are detensioned, they may be handled and moved, but the units shall not be transported from the casting yard until the 28 day design compressive strength has been attained and verified by compressive tests of cylinders that have been cured with the units.

Prestressed units shall be transported in an upright position, and points of support and directions of the reactions with respect to the unit shall be approximately the same during transportation and storage as when the unit is in its final position. The units shall be handled only by the lifting devices with adequate equipment and proper hoisting procedures so that only a vertical pull will be applied to the lifting devices.

Each member shall be marked with paint on the top surface with an erection mark for identification and an erection diagram shall be furnished with erection marks shown thereon.

The Contractor shall furnish the Engineer as many copies of shipping statements and erection diagrams as the Engineer may direct.

Units stored at the site of the project shall be properly supported above the ground and protected from discoloration and damage.

Units damaged by improper storing, hoisting or handling shall be replaced by the Contractor at his own expense.

535.24 Bearings. Prestressed units shall not be placed upon bearing areas which are improperly finished, deformed, or irregular. Bearing pads shall be installed as shown on the plans.

535.25 Lateral Post-Tensioning. Lateral post-tensioned strands, where called for, shall be 12.70 mm [$\frac{1}{2}$ inch] - grade 270 and shall be installed as shown on plans, except 11.11 mm [$\frac{7}{16}$ inch] diameter post-tensioning bars may be used subject to the approval of the Engineer. Precautions shall be taken not to obstruct post-tensioning ducts when longitudinal keyways are grouted. Gaskets made of compressible material will be required at adjoining duct openings.

Shear key material shall be an approved polymer modified cementitious mortar applied in accordance with the manufacturer's recommendations. The keyway surface shall be sandblast cleaned of any material which may prevent bonding. This work may be done at the fabrication plant or in the field, however, it shall be done prior to erection. If sandblasting is to be done at the plant, the shop drawings shall so indicate. Prior to placing the shear key material, there shall be no force in the lateral tensioning strands, and the anchorage system shall be installed. Immediately before filling the keyway, it shall be cleared of all debris. The sealing material below the shear key shall be at least 6 mm [$\frac{1}{4}$ inch] below the shear key bottom. The ends of the keyway shall be sealed to prevent material loss.

A tension of 129,000 N [29,000 lb..] per strand shall be applied. After tensioning, the ends of the strands shall be burned or cut off not closer than 32 mm [$1\frac{1}{4}$ inches] from the end of the wedge.

The lateral ducts shall be pumped full with grout with a consistency of thick paint but proportioned so that free water will not separate out of the mix. The grout to be pumped shall be a mixture of cement and fine sand (100 percent passing a 600 m [No. 30] sieve) in the approximate proportions of one part cement to 0.75 part sand with a maximum of 45 L of water per 100 kg [5 gallons of water per bag] of cement. A calcium nitrite admixture shall be added to the grout at the rate of 1 percent of calcium nitrite by weight of cement. The water in the calcium nitrite solution shall be counted as mixing water. Exact proportions shall be adjusted to obtain a grout of proper consistency. Unpolished aluminum powder may be added in an amount not to exceed 10 cc per 42.6 kg [2 teaspoons per bag] of cement. Sufficient pressure shall be used in grouting to force the grout completely through the duct. Pumping equipment for grouting shall be subject to the approval of the Engineer. Where temporary post-tensioning ducts are called for on the plans, grouting of these ducts will not be required.

End recesses at lateral post-tensioning ducts, anchor bolts and other areas requiring grouting shall be packed with a grout of stiff consistency conforming, in general, to Subsection 705.02, except that portland cement Type III with an air entraining admixture may be used. Recesses at ends of lateral posttensioning ducts shall be filled with grout using the same cement as that in the prestressed slabs. All such grouting shall be completed within a 10 day period following the lateral posttensioning. All grouting shall be done with an approved nonshrink grout. The limits to be used in determining the quantities for the purpose of arriving at a lump sum bid price will be the entire precast, prestressed superstructure, outside to outside, both transversely and longitudinally, fabricated, delivered and erected as shown on the plans.

535.26 through 535.34 Vacant.

535.35 Method of Measurement. Prestressed structural concrete will be measured by the lump sum. The limits will be the entire prestressed concrete superstructure, outside to outside both transversely and longitudinally.

535.36 Basis of Payment. All work done under Prestressed Structural Concrete will be paid for at the contract lump sum price for the respective item. Payment will be full compensation for furnishing all materials wholly or partly in the precast prestressed unit including anchor dowels, reinforcing steel, and related materials or work in the unit erected as shown on the plans. Related materials or work will include, but not be necessarily limited to, preformed pads, drilling and grouting of anchor dowels, grouting of keyways and ducts, post-tensioning operations and any concrete admixtures used.

Payment will be made under:

Pay Item

Pay Unit

535.60 Prestressed Structural Concrete Slab

Lump Sum

535.61 Prestressed Structural Concrete I-Girders

Lump Sum

535.62 Prestressed Structural Concrete Box Beams

Lump Sum

DIVISION 600 -- INCIDENTAL CONSTRUCTION

SECTION 601 -- GABIONS AND MATTRESSES

601.01 Description. This work shall consist of furnishing, assembling, filling with stones and lacing hexagonal mesh wire baskets, hereafter called gabions or mattresses, constructed in accordance with these specifications and placed in conformity with the lines, grades and dimensions shown on the plans or established.

MATERIALS

601.02 Materials. Materials shall conform to the requirements specified in the following Subsections of Division 700 -- Materials.

Gabion	711.02
Stones for Gabions	711.03
Mattresses	711.07
Stones for Mattresses	711.08

601.03 Fabrication. Gabions and mattresses shall be manufactured so that their sides, ends, lid and diaphragm(s) can be assembled to form rectangular units of the specified dimensions.

Gabions shall be of a single unit construction. The front, base, back and lid shall be woven into a single unit. The ends and diaphragm(s) shall be factory connected to the base.

The base, sides and two ends of mattresses shall be of a single unit construction woven into a single unit. Diaphragm(s) shall be factory connected to the base. The lid may be a separate unit.

Perimeter edges of the mesh forming the gabion or mattress shall be securely salvaged so that joints have at least the same strength as the wire mesh itself.

The wire mesh shall be fabricated to be non-raveling. Non-raveling is defined as the ability to resist pulling apart at any of the twists or connections forming the mesh when a single wire in a section of mesh is cut and the section of mesh then subject to the load test described in the materials specification.

The gabion length shall be 1½, 2, 3 or 4 times its horizontal width. The horizontal width shall not be less than 900 mm [36 inches]. However, all gabions furnished by the manufacturer shall be of uniform width. Where the gabion length exceeds 1½ times its horizontal width, the gabion shall be equally divided into cells by diaphragm(s) of the same mesh and gauge as the gabion body.

Mattresses shall be at least 1.8 m by 1.8 m [6 foot by 6 foot] and equally divided by transverse diaphragms.

CONSTRUCTION REQUIREMENTS

601.04 Assembling. Gabions and mattresses shall be supplied folded flat, tied in pairs and packed in bundles. Single units shall be removed from the bundle, unfolded flat on the ground and all kinks and bends flattened.

The units shall be assembled individually by erecting the front side, back side, ends and diaphragm(s), assuring that all creases are in the correct position and the tops of all sides level.

The four corners of each unit shall be laced first, followed by the edges of internal diaphragm(s) to the sides.

The lacing procedures for lacing corners and units together shall consist of cutting a length of lacing wire approximately 1½ times the distance to be laced, not to exceed 1.5 m [5 feet], securing the wire terminal at the corner by looping and twisting, then proceeding to lace with alternating single and double loops at approximately 125 mm [5 inch] intervals and securely fasten the other wire terminal.

The mattresses shall not be assembled in their final location, except as required for lacing adjacent units together. This is to maintain a uniform bedding surface for installation as described in Subsection 601.051.

At the option of the Contractor, approved locking wire fasteners may be used in lieu of lacing wire provided they are used in every mesh opening along the joint, each ring is formed such that the ends interlock and the fasteners be of stainless steel construction with a minimum thickness of 3.17 mm [0.125 inches], meeting the requirements of ASTM A213, Type 302.

601.05 Installation of Gabions. The assembled gabion units shall be placed in the proper location. All adjoining empty gabions shall be placed along the perimeter of the gabion contact surfaces to obtain a monolithic structure.

Once the gabion units are laced together, they shall be stretched to effective alignment. This operation shall be carried out after several empty gabion units have been positioned. The first gabion in the line shall be partially filled to provide the necessary anchorage prior to stretching. Stretching shall be carried out using a means of stretching of at least 900 kg [one ton] capacity.

While under tension, the gabion shall be carefully controlled against any possible unraveling.

Whenever gabion structures require more than one tier, the upper empty gabion tier, while under tension, shall be laced to the top of the lower one.

601.051 Installation of Mattresses. If the mattress is to be placed in the dry, the assembled unit shall be placed in the proper location after it is assembled as described in Subsection 601.04. Several empty units shall be laced together along the contact surfaces to obtain a monolithic structure. Care shall be taken to maintain a uniform surface on the bedding material.

If the mattresses are to be placed underwater, they may be laced together and filled in the dry and then placed in final position.

If the mattresses are polyvinylchloride coated, they shall not be dragged, but shall be placed in a manner so as not to damage the coating.

601.06 Filling. Gabions and mattresses shall be filled by earth handling equipment such as backhoe, gradually, crane, by hand or any combination.

Care shall be taken when placing fill material to assure that the sheathing on coated units will not be broken or damaged.

Gabions shall be filled in layers, 300 mm [1 foot] at a time. Two connecting wires shall be placed between each layer in all cells along all exposed faces of the gabion structure. All connecting wires shall be looped around two mesh openings and the wire terminals shall be securely twisted to prevent their loosening.

The cells in any row shall be filled in stages so that local deformation will be avoided. At no time shall any cell be filled to a depth exceeding 300 mm [1 foot] more than the adjoining cell.

Along all exposed gabion faces, the outer layer of stone shall be carefully placed and packed by hand to ensure proper alignment and a neat, compact, square appearance.

The last layer of stone shall be leveled with the top of the gabion or mattress to allow proper closing of the lid and provide an even surface for the next course.

Gabions and mattresses shall be well packed and full without excessive bulging.

601.061 Filling of Hand Filled Gabions. The assembled gabion units shall be placed on the proper location. A form shall then be placed along the front face, and any side face not adjacent to an already placed gabion, and anchored to formwork on the back face to provide a rigid frame rectangle before filling with stone.

The forms shall be sufficiently braced and tied to prevent distortion while the stones are being placed.

On all exposed gabion faces, the outer layer of stone shall be carefully placed and packed by hand to ensure proper alignment and a neat, compact, square appearance.

Care shall be taken when placing fill material to assure that the sheathing on coated units will not be broken or damaged.

Gabions shall be filled by hand in 300 mm [1 foot] layers. Two connecting wires shall be placed between each layer in all cells along all exposed faces of the gabion structure. All connecting wires shall be looped around two mesh openings and the wire terminals shall be securely twisted to prevent their loosening.

The cells in any row shall be filled in stages so that local deformation will be avoided. At no time shall any cell be filled to a depth exceeding 300 mm [1 foot] more than the adjoining cell.

The last layer of stone shall be leveled with the top of the gabion or mattress to allow proper closing of the lid and provide an even surface for the next course.

At no time will any stones be placed by machine.

Complete gabions shall have a maximum deviation from the designated shape of 25 mm in 1 m [1 inch in 3 feet]. Gabions not meeting this tolerance will be emptied, adjustments made, and refilled.

601.07 Lid Closing. The lids shall be stretched tightly over the filling, using crow bars or lid closing tools, until the lid meets the perimeter edges of the front and end panels. The lid shall then be tightly laced along all edges, ends and diaphragms in the same manner as described above for assembly.

601.08 Cutting and Folding Mesh. Where shown on the drawings or when otherwise directed, the mesh shall be cut, folded and wired together to suit existing site conditions. The mesh must be cleanly cut and the surplus mesh cut out completely or folded back and neatly wired to an adjacent face. The cut edges of the mesh shall be securely laced together with lacing wire in the manner as described above for assembling.

601.09 Method of Measurement. Gabions and mattresses will be measured for payment by the cubic meter [cubic yard] to the neat line dimensions shown on the plans.

601.10 Basis of Payment. Payment for gabions and mattresses will be made at the contract unit price per cubic meter [cubic yard] in place. Payment will be full compensation for excavating to place gabions and backfill material, for preparing and fine grading the foundations area, for furnishing and placing backfill material under and behind the gabions and for furnishing and placing all necessary gabion units including wire mesh baskets, lacing wire, rock fill and all labor and equipment necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
601.21 Gabions, Galvanized	cubic meter [Cubic Yard]
601.22 Gabions, PVC Coated	cubic meter [Cubic Yard]
601.221 Gabions, PVC Coated and Hand Filled	cubic meter [Cubic Yard]
601.23 Mattresses, Galvanized: _____	cubic meter [Cubic Yard]
601.24 Mattresses, PVC Coated: _____	cubic meter [Cubic Yard]

SECTION 602 -- VACANT

SECTION 603 -- PIPE CULVERTS AND STORM DRAINS

603.01 Description. This work shall consist of constructing or reconstructing pipe culverts and storm drains, in accordance with these specifications, the Standard Detail plans and in reasonably close conformity with the lines and grades shown on the plans or established.

The word "pipe" in these specifications shall include both round pipe and pipe arches.

MATERIALS

603.02 Materials. Material shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Joint Mortar	705.02
Flexible Gaskets	705.03
Flexible Culvert Polyvinylchloride (PVC) Pipe	706.08
Corrugated Steel, Metallic Coated Pipe	707.02
Fiber-bonded Corrugated Steel Pipe & Pipe Arches	707.04
Corrugated Aluminum Alloy Pipe & Pipe Arches	707.06
Polymer Precoated, Galvanized Corrugated Steel Pipe & Pipe Arches	707.07
Aluminum Coated (Type 2) Corrugated Steel Pipe	707.10
Zinc-Coated (Galvanized) Corrugated Steel Pipe Rigid Culvert	707.11
Reinforced Concrete Pipe	706.02

Flexible culverts with a diameter of 1200 mm [48 inches] or more shall have the ends cut to a partial bevel as called for on the plans. The cut ends of galvanized steel pipe shall be regalvanized or painted with a zinc aluminum paint conforming to Federal Specification TT-P-1561A or approved equal.

Helical corrugated pipe shall be rerolled to form angular corrugations on the ends.

The corrugated bands for connecting pipe with 68 x 13 mm [2 2/3 x 1/2 inch] corrugations shall be not less than 265 mm [10½ inches] wide.

Rigid culverts, designated to have the ends shaped to a partial bevel, shall be either cast or cut to the required shape and dimensions. In either case the edges of the pipe shall be even and true with no exposed reinforcing.

CONSTRUCTION REQUIREMENTS

603.03 General. Culvert pipe and pipe arches shall be furnished under the following options unless otherwise specified.

Option I. The Contractor shall furnish any of the following type of pipe under Option I:

Corrugated Steel, Metallic (zinc or aluminum) Coated Pipe
Reinforced Concrete Pipe

Also any of the metal pipe allowed under Option III.

Option III. The Contractor shall furnish any of the following types of pipe under Option III. (Corrugated pipe used under this option shall be adequate to equal the flow capacity of comparable smoothlined pipe):

Fiber-bonded Corrugated Steel Pipe
Corrugated Aluminum Alloy Pipe
Polyvinylchloride (PVC) Pipe
Polymer-Precoated Galvanized Corrugated Steel Pipe
Reinforced Concrete Pipe

Within any single run of culvert pipe, including extensions of existing culverts, the type of pipe shall be the same unless otherwise specified or as directed by the Engineer. In a closed drainage system a run of culvert pipe shall be considered from catch basin to catch basin. In an open drainage system a run of culvert shall be considered from inlet to outlet.

Option III polyvinylchloride (PVC) pipe shall only be used in closed drainage systems between catch basins.

603.031 Excavation. Trenches shall be excavated in accordance with the requirements of Section 206 -- Structural Excavation and wide enough to allow joining the culvert and compacting the bedding and backfill material under and around the culvert. Unless otherwise designated, trench walls shall be as nearly vertical as possible and the trench width no greater than necessary for installation of the culvert.

603.04 Bedding. Culverts less than 1050 mm [42 inches] in diameter shall be bedded on a firm foundation of uniform density. After placing the culvert pipe, backfill material shall be placed along the bottom of the trench, thoroughly tamped against the lower portion of the pipe with special care taken not to move the bedded pipe.

For culverts 1050 mm [42 inches] in diameter and larger, the bottom of the trench shall be compacted to uniform density and shaped to fit a template with reasonable closeness for at least 10 percent of the culvert's total height.

On all bedding, when bell and spigot pipe is used, the portion of trench at the joints shall be shaped to fit the bell.

603.05 Laying Culvert. The Contractor shall not install nor backfill culverts between December 15th and April 1st without written permission. Installing shall begin at the downstream end of the culvert line. Bell or groove ends of rigid culverts shall be placed facing upstream.

Elliptically shaped culverts shall be placed with the major axis within 5 degrees of vertical. Elliptically reinforced concrete pipe shall be placed with the vertical axis, indicated by the manufacturer, within 5 degrees of vertical.

603.06 Joining Culverts. The method of joining rigid culvert sections shall be such that the ends are fully entered and the inner surfaces are reasonably flush and even. Joints shall be made with portland cement mortar, portland cement grout, rubber ring gaskets or flexible plastic gaskets.

The pipe ends shall be thoroughly cleaned before the joint is made. Mortared joints shall be made with an excess of mortar to form a bead around the outside of the culvert and finished smooth inside. For grouted joints, molds or runners shall be used to retain the poured grout.

Joints with rubber ring gasket or flexible plastic gasket shall be made in accordance with the manufacturer's recommended procedures.

When portland cement mixtures are used, the completed joints shall be covered to protect against drying.

Flexible culvert section and metal end sections shall be firmly jointed by coupling bands. These bands shall meet the same applicable requirements as the flexible culvert being joined.

603.07 Shop Strutting. All flexible circular culvert pipe 1200 mm [48 inches] in diameter and larger shall be elongated along the vertical diameter in accordance with one of the following two methods:

- (a) The pipe shall be elongated by the manufacturer after fabrication by increasing the diameter along the vertical axis approximately 3 percent with a corresponding decrease along the horizontal axis. The elongation shall be obtained by installing rods and tightening the rods, uniformly from end to end of the pipe, obtaining approximately one quarter of the required elongation each time throughout the length of the pipe.

The rods shall be 16 mm [5/8 inch] diameter threaded 180 mm [7 inches] at both ends with washers and nuts. The length of the rods shall be the diameter of the pipe plus 200 mm [8 inches]. The rods shall be placed on the horizontal axis of the pipe at 600 mm [2 foot] spacing and located halfway between the circumferential riveting. A block of soft wood 50 mm by 100 mm by 300 mm long [2 inches by 4 inches by 12 inches long], shall be placed over the rods at each end to provide contact against the outside of the pipe. The long dimension of the blocks shall be parallel with the horizontal axis of the pipe. The rods shall be left in the pipe until the fill is completed and compacted, unless for some unusual condition their removal is ordered. The rods shall be removed by cutting from the inside adjacent to the pipe.

- (b) The pipe shall be elongated by the manufacturer by increasing the diameter along the vertical axis approximately 5 percent with a corresponding decrease along the horizontal axis by applying sufficient pressure to the sides of the pipe after fabrication to produce the specified distortion. The elongation shall be maintained by drilling holes in the ends of the pipe sections and placing and tightening horizontal wires. After the pipe sections have been installed with coupling bands, the wires shall be removed.

Helically corrugated culvert sections shall be match marked before being elongated by the manufacturer or before the 16 mm [5/8 inch] diameter rods are installed.

603.08 Backfilling Culverts and Storm Drains. After the pipe is installed, it will be inspected before any backfill material is placed. All pipe found to be out of alignment, unduly settled or damaged to the extent that full performance is impaired, shall be taken up and re-laid or replaced.

Trenches shall be backfilled in accordance with Subsection 206.03 and as follows. The backfill material shall be thoroughly rammed under the haunches of the pipe with power or pneumatic operated hand tampers. The remainder of the backfill shall be thoroughly compacted with power tampers or vibratory compactors or other approved equipment or combination of equipment.

When the top of the pipe is exposed above the top of the trench, the embankment material around the pipe shall be placed and compacted on each side of the pipe in the aforementioned manner described for backfilling trenches, for a width of 1.5 m [5 feet] measured from the outside diameter of the pipe. Only that portion of the embankment on each side and top of the pipe, for a minimum distance of 400 mm [15 inches] measured from the outside diameter of the pipe, must be of material conforming to the requirements described for backfilling in Subsection 206.03. Backfill material beyond these limits may contain stones larger than 75 mm [3 inches] but no greater than the thickness of the layer being placed. The embankment construction around the pipe shall continue up to an elevation 400 mm [15 inches] above the top of the pipe. Above and beyond these limits the embankment shall be placed and compacted in accordance with the embankment construction requirements specified for the work except where the induced trench method is called for on the plans.

When construction equipment is used or traffic is maintained the Contractor shall provide a minimum cover of 1 m [3 feet] over all pipes, if possible. Whenever this cover extends above the subgrade the Contractor shall temporarily place earth which shall be removed when necessary to complete the work in accordance with the plans or as directed. Any deviation from this practice shall have prior approval.

603.09 Induced Trench. Under this method, for designated rigid pipes only, the embankment shall be completed as specified above, to a height above the culvert equal to the vertical outside diameter of the pipe plus 300 mm [1 foot]. A trench, equal in width to the outside horizontal diameter of the pipe, shall then be excavated to within 300 mm [1 foot] of the top of the pipe. Trench walls shall be as nearly vertical as possible. Hay bales shall be used to fill the lower 1/4 to 1/3 of the trench. Construction of the embankment above shall then proceed in a normal manner. The trench shall be loosely filled with highly compressible soil.

603.10 Removing and Relaying Culverts. The pipe shall be carefully removed from its existing location, transported to and installed in the new location in accordance with these specifications for the particular type of pipe involved. Pipe damaged by the Contractor shall be replaced with pipe of similar type by the Contractor without additional compensation.

New metal bands or joint material shall be supplied and installed when necessary.

603.11 Method of Measurement. Culvert and storm drain pipe of the different types and sizes, both new and re-laid, will be measured by the length in meter [linear feet] along the invert, laid as directed, complete in place and accepted. Pipe laid in excess of the authorized length will not be included.

When the ends of a pipe are sloped or skewed the amount to be included for payment shall be the length along the invert of the pipe.

When elbows, tees, wyes, or other special fittings are required, each fitting shall be included for payment as one additional meter [three additional linear feet] of the largest pipeline involved.

Inlet grate units will be measured by each unit installed, complete in place and accepted.

603.12 Basis of Payment. The accepted quantities of pipe for culverts and storm drains will be paid for at the contract unit price per meter [linear foot], for the types and sizes specified, complete in place.

No payment will be made for pipe ordered without written approval of the Engineer when such pipe is not required to be installed for completion of the work.

Excavation for culverts and storm drains, including excavation below the pipe, for induced trench and for bedding and backfilling will be measured and paid for as provided in Section 206 -- Structural Excavation.

Whenever minimum cover material extends above the subgrade, removal of the cover material necessary to complete the work will not be paid for directly but shall be considered part of the work specified herein.

Coupling bands and joint material will not be paid for separately but shall be considered included in the unit bid price for the type of pipe being used or re-laid.

Existing culverts to be re-laid, salvaged or wasted shall be removed and disposed of as directed. The excavation for removal of these culverts that is not paid for under other items or incidental to other items shall be paid for as Common Excavation.

Inlet grate units will be paid for at the contract unit price each for the size specified, complete in place.

Payment will be made under:

Pay Items -	Metric Units	Pay Unit
603.15	300 mm Culvert Pipe Option I	meter
603.16	375 mm Culvert Pipe Option I	meter
603.17	450 mm Culvert Pipe Option I	meter
603.18	525 mm Culvert Pipe Option I	meter
603.19	600 mm Culvert Pipe Option I	meter
603.20	750 mm Culvert Pipe Option I	meter
603.21	900 mm Culvert Pipe Option I	meter
603.159	300 mm Culvert Pipe Option III	meter
603.169	375 mm Culvert Pipe Option III	meter
603.179	450 mm Culvert Pipe Option III	meter
603.189	525 mm Culvert Pipe Option III	meter
603.199	600 mm Culvert Pipe Option III	meter
603.2009	675 mm Culvert Pipe Option III	meter
603.209	750 mm Culvert Pipe Option III	meter
603.2019	825 mm Culvert Pipe Option III	meter
603.219	900 mm Culvert Pipe Option III	meter
603.229	1050 mm Culvert Pipe Option III	meter
603.239	1200 mm Culvert Pipe Option III	meter
603.249	1350 mm Culvert Pipe Option III	meter
603.259	1500 mm Culvert Pipe Option III	meter
603.269	1650 mm Culvert Pipe Option III	meter
603.279	1800 mm Culvert Pipe Option III	meter
603.289	2100 mm Culvert Pipe Option III	meter
603.30	525 mm span 375 mm rise Pipe Arch Opt.III	meter
603.31	600 mm span 450 mm rise Pipe Arch Opt.III	meter
603.32	700 mm span 500 mm rise Pipe Arch Opt.III	meter
603.33	875 mm span 600 mm rise Pipe Arch Opt.III	meter
603.34	1050 mm span 725 mm rise Pipe Arch Opt.III	meter
603.35	1225 mm span 825 mm rise Pipe Arch Opt.III	meter
603.36	1425 mm span 950 mm rise Pipe Arch Opt.III	meter
603.37	1600 mm span 1075 mm rise Pipe Arch Opt.III	meter
603.38	1650 mm span 1275 mm rise Pipe Arch Opt.III	meter
603.39	1825 mm span 1375 mm rise Pipe Arch Opt.III	meter
603.40	2025 mm span 1475 mm rise Pipe Arch Opt.III	meter
603.41	610 mm Reinforced Concrete Pipe Class IV	meter
603.42	762 mm Reinforced Concrete Pipe Class IV	meter
603.43	914 mm Reinforced Concrete Pipe Class IV	meter
603.44	1067 mm Reinforced Concrete Pipe Class IV	meter
603.45	1219 mm Reinforced Concrete Pipe Class IV	meter
603.46	1372 mm Reinforced Concrete Pipe Class IV	meter
603.47	1524 mm Reinforced Concrete Pipe Class IV	meter
603.48	1676 mm Reinforced Concrete Pipe Class IV	meter
603.49	1829 mm Reinforced Concrete Pipe Class IV	meter
603.50	through 603.72 Vacant	
603.73	Remove and Relay Metal Pipe: ____	meter

603.74	Remove and Relay Concrete Pipe: ____	meter
603.75	150 mm Inlet Grate Unit	Each
603.76	300 mm Inlet Grate Unit	Each
603.77	375 mm Inlet Grate Unit	Each
603.78	450 mm Inlet Grate Unit	Each
603.79	525 mm Inlet Grate Unit	Each
603.80	600 mm Inlet Grate Unit	Each
603.81	750 mm Inlet Grate Unit	Each
603.82	900 mm Inlet Grate Unit	Each

Pay Items - English Units

Pay Unit

603.15	12 inch Culvert Pipe Option I	Linear Foot
603.16	15 inch Culvert Pipe Option I	Linear Foot
603.17	18 inch Culvert Pipe Option I	Linear Foot
603.18	21 inch Culvert Pipe Option I	Linear Foot
603.19	24 inch Culvert Pipe Option I	Linear Foot
603.20	30 inch Culvert Pipe Option I	Linear Foot
603.21	36 inch Culvert Pipe Option I	Linear Foot
603.159	12 inch Culvert Pipe Option III	Linear Foot
603.169	15 inch Culvert Pipe Option III	Linear Foot
603.179	18 inch Culvert Pipe Option III	Linear Foot
603.189	21 inch Culvert Pipe Option III	Linear Foot
603.199	24 inch Culvert Pipe Option III	Linear Foot
603.2009	27 inch Culvert Pipe Option III	Linear Foot
603.209	30 inch Culvert Pipe Option III	Linear Foot
603.2019	33 inch Culvert Pipe Option III	Linear Foot
603.219	36 inch Culvert Pipe Option III	Linear Foot
603.229	42 inch Culvert Pipe Option III	Linear Foot
603.239	48 inch Culvert Pipe Option III	Linear Foot
603.249	54 inch Culvert Pipe Option III	Linear Foot
603.259	60 inch Culvert Pipe Option III	Linear Foot
603.269	66 inch Culvert Pipe Option III	Linear Foot
603.279	72 inch Culvert Pipe Option III	Linear Foot
603.289	84 inch Culvert Pipe Option III	Linear Foot
603.30	21 inch span 15 inch rise Pipe Arch Opt.III	Linear Foot
603.31	24 inch span 18 inch rise Pipe Arch Opt.III	Linear Foot
603.32	28 inch span 20 inch rise Pipe Arch Opt.III	Linear Foot
603.33	35 inch span 24 inch rise Pipe Arch Opt.III	Linear Foot
603.34	42 inch span 29 inch rise Pipe Arch Opt.III	Linear Foot
603.35	49 inch span 33 inch rise Pipe Arch Opt.III	Linear Foot
603.36	57 inch span 38 inch rise Pipe Arch Opt.III	Linear Foot
603.37	64 inch span 43 inch rise Pipe Arch Opt.III	Linear Foot
603.38	66 inch span 51 inch rise Pipe Arch Opt.III	Linear Foot
603.39	73 inch span 55 inch rise Pipe Arch Opt.III	Linear Foot
603.40	81 inch span 59 inch rise Pipe Arch Opt.III	Linear Foot
603.41	24 inch Reinforced Concrete Pipe Class IV	Linear Foot
603.42	30 inch Reinforced Concrete Pipe Class IV	Linear Foot
603.43	36 inch Reinforced Concrete Pipe Class IV	Linear Foot

603.44	42 inch Reinforced Concrete Pipe Class IV	Linear Foot
603.45	48 inch Reinforced Concrete Pipe Class IV	Linear Foot
603.46	54 inch Reinforced Concrete Pipe Class IV	Linear Foot
603.47	60 inch Reinforced Concrete Pipe Class IV	Linear Foot
603.48	66 inch Reinforced Concrete Pipe Class IV	Linear Foot
603.49	72 inch Reinforced Concrete Pipe Class IV	Linear Foot
603.50	through 603.72 Vacant	
603.73	Remove and Relay Metal Pipe: ____	Linear Foot
603.74	Remove and Relay Concrete Pipe: _____	Linear Foot
603.75	6 inch Inlet Grate Unit	Each
603.76	12 inch Inlet Grate Unit	Each
603.77	15 inch Inlet Grate Unit	Each
603.78	18 inch Inlet Grate Unit	Each
603.79	21 inch Inlet Grate Unit	Each
603.80	24 inch Inlet Grate Unit	Each
603.81	30 inch Inlet Grate Unit	Each
603.82	36 inch Inlet Grate Unit	Each

SECTION 604 -- MANHOLES AND CATCH BASINS

604.01 Description. This work shall consist of constructing, altering or adjusting to grade manholes and catch basins in accordance with these specifications, and in reasonable close conformity with the lines and grades shown on the plans or established.

MATERIALS

604.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Portland Cement	701.01
Clay or Shale Brick	704.01
Concrete Masonry Blocks	704.03
Joint Mortar	705.02
Reinforcing Steel	709.01
Stone Curbing and Edging	712.04
Precast Concrete Units	712.06
Tops, Traps	712.07
Corrugated Metal Units	712.08
Catch Basin and Manhole Steps	712.09

Except as otherwise provided on the plans, concrete for these structures shall meet the requirements of Section 502 -- Structural Concrete.

Catch basin grates shall be either the type of grate shown on the Standard Details or an approved equal.

CONSTRUCTION REQUIREMENTS

604.03 Construction Requirements. Concrete catch basins and manholes shall be constructed of precast units, except that concrete blocks may be used around inlet and outlet pipes. Joints for precast concrete units shall be of portland cement mortar, rubber gaskets, flexible plastic rings, mastic joint filler or other approved types to form a watertight joint. Joints for concrete blocks shall be of portland cement mortar, not more than 12 mm [1/2 inch] wide, completely filled and neatly tooled on the inside of the structure.

Metal catch basins shall be corrugated metal pipe units mounted on a portland cement concrete foundation.

Catch basins and manholes shall be placed to the required grade on a compacted foundation of uniform density. Inlet and outlet pipe elevations may vary from the elevations shown on the plans depending upon field conditions.

Pipe sections entering catch basins shall be firmly connected to the structure wall with no part of the pipe projecting more than 150 mm [6 inches] inside the wall. When a section of culvert has to be cut, the end shall be finished in a workmanlike manner.

Metal frames and traps, when called for, shall be set in a bed of clay bricks or shale bricks and mortar or otherwise secured as shown on the plans. Castings shall be set to the correct elevation before the next final course of paving material has been placed.

Upon completion, each catch basin and manhole shall be cleaned of all accumulation of silt, debris or foreign matter and shall be kept clean until final acceptance of the work.

604.04 Altering Catch Basins and Manholes. Existing catch basins and manholes to be altered or adjusted, shall be reconstructed to the required grade using new or existing metal frames and tops as specified.

When altering or adjusting, the existing catch basin or manhole shall be dismantled sufficiently to allow reconstruction in accordance with the applicable requirements as shown on the Standard Detail plans for complete catch basins and manholes. When existing frames, covers and grates are used they shall be thoroughly cleaned of existing mortar before placing to the new grade.

- (a) Altering Catch Basins. The existing top assembly shall be removed and replaced with a new Type A or Type B frame and special grate set to the required grade as directed.
- (b) Rebuilding Catch Basins. The existing top assembly and cone section shall be removed, the cone section rebuilt, a new frame and grate furnished and installed at the required line and grade as directed. Concrete blocks may be used below the cone section if necessary due to existing conditions.

All unused salvaged material, including grates and frames will become the property of the Contractor unless otherwise specified.

Each catch basin and manhole that is rebuilt, shall be cleaned of all accumulated silt, debris and other foreign matter prior to final acceptance of the work.

604.05 Method of Measurement. Catch basins and manholes and accessories of the respective types will be measured by the number of units, measured as follows, complete and accepted in place.

- (a) Complete Structures. Each catch basin and manhole having a depth up to 2.5 m [8 feet] from the top of the grate or cover to the top of the floor, measured to the nearest 0.5 m [foot], will be one unit. One-fifth of a unit [One-eighth of a unit] will be added for each additional 0.5 m [foot] over 2.5 m [8 feet] measured to the nearest 0.5 m [foot]. Depth measurements in excess of the dimensions authorized will not be included.
- (b) Existing Structures. Existing catch basins and manholes to be altered, adjusted or rebuilt will be one unit each. Existing catch basins and manholes that have been altered or adjusted that require cleaning will be one unit each.
- (c) Trap. Each trap included in the completed structure will be one unit each.
- (d) Step. Each step included in the completed structure will be one unit each.

604.06 Basis of Payment. The accepted quantities of catch basins, manholes, traps and steps, will be paid for at the contract unit price each of the respective types complete in place. Payment for rebuilding, adjusting or altering catch basins and manholes shall include furnishing all materials including new blocks, bricks, mortar and metal tops and covers and curb inlets when required. Frames, grates and covers for new or rebuilt catch basins or manholes shall be considered part of the structure and no separate payment will be made. Payment for cleaning existing catch basins and manholes will be paid for at the contract unit price each. There will be no payment for cleaning new basins and manholes and those reconstructed. Payment will be full compensation for supplying all equipment and labor to clean the basins and manholes and to dispose of the waste.

Excavation and backfill will be measured and paid for as provided in Section 206 -- Structural Excavation.

Payment will be made under:

Pay Item	Pay Unit
604.072 Catch Basin Type A1-C	Each
604.082 Catch Basin Type A2-C	Each
604.09 Catch Basin Type B1	Each
604.092 Catch Basin Type B1-C	Each
604.10 Catch Basin Type B2	Each
604.102 Catch Basin Type B2-C	Each
604.11 Catch Basin Type C1	Each
604.12 Catch Basin Type C2	Each
604.13 600 mm [24 inch] Catch Basin Type E	Each
604.14 750 mm [30 inch] Catch Basin Type E	Each
604.15 Manhole	Each
604.16 Altering Catch Basin to Manhole	Each
604.161 Altering Catch Basin	Each
604.164 Rebuilding Catch Basin	Each
604.166 Rebuilding Manhole	Each
604.17 Altering Manhole to Catch Basin	Each
604.18 Adjusting Manhole or Catch Basin to Grade	Each
604.182 Cleaning Existing Catch Basin and Manhole	Each
604.19 200 mm [8 inch] Trap	Each
604.20 300 mm [12 inch] Trap	Each
604.21 375 mm [15 inch] Trap	Each
604.22 450 mm [18 inch] Trap	Each
604.23 Step	Each
604.242 Catch Basin Type F3	Each
604.243 Catch Basin Type F3-C	Each
604.244 Catch Basin Type F4	Each
604.245 Catch Basin Type F4-C	Each
604.246 Catch Basin Type F5	Each
604.247 Catch Basin Type F5-C	Each
604.248 Catch Basin Type F6	Each
604.249 Catch Basin Type F6-C	Each
604.25 Catch Basin Type A5	Each
604.252 Catch Basin Type A5-C	Each
604.26 Catch Basin Type B5	Each
604.262 Catch Basin Type B5-C	Each

SECTION 605 -- UNDERDRAIN

605.01 Description. This work shall consist of the construction of underdrain, using pipe and filter material and pipe outlets in accordance with these specifications and the standard detail plans and in reasonably close conformity with the lines and grades shown on the plans or established.

MATERIALS

605.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Granular Borrow	703.19
Underdrain Backfill Material	703.22

Underdrain Pipe

Corrugated Polyethylene Drainage Tubing for Underdrain	706.06
Polyvinylchloride (PVC) Perforated Pipe	706.09
Corrugated Steel, Metallic Coated Pipe for Underdrain	707.05
Corrugated Aluminum Alloy Pipe for Underdrain	707.08

Underdrain Outlet Pipe

Corrugated Steel, Metallic Coated Pipe for Underdrain	707.02
Corrugated Aluminum Alloy Pipe	707.06

Connections for polyethylene underdrain tubing shall be made with external wrap-around split couplings, screw-on type couplings, or external snap-on couplings. External wrap-around split couplings shall be secured with heavy duty splicing tape or plastic or wire ties placed on each side of the coupling. External snap-on couplings shall comply with the appropriate section of AASHTO specifications.

Connections for other plastic underdrain pipe shall be made with bell and spigot and ring gasket.

Connections for metallic underdrain pipe shall be made with corrugated metal bands secured with bolts. Dimpled bands shall not be used.

Other types of connectors for underdrain may be used upon approval by the Engineer.

605.021 Fittings. The material for elbows, tees and wyes for Underdrain pipe shall be at least as thick as the largest size pipe being connected.

CONSTRUCTION REQUIREMENTS

605.03 General. Underdrain pipe for Underdrain, Type B shall, at the Contractor's option, consist of any one of the following types:

Corrugated Aluminum Alloy Pipe for Underdrain
Corrugated Polyethylene Drainage Tubing for Underdrain (Smoothlined)
Metallic Coated (Zinc or Aluminum Coated) Corrugated Steel Pipe for Underdrain
Polyvinylchloride (PVC) Perforated Pipe

Underdrain pipe for Underdrain Type C shall, at the Contractor's option, consist of any one of the following types:

Corrugated Aluminum Alloy Pipe for Underdrain
Corrugated Polyethylene Pipe (Smoothlined)
Metallic Coated (Zinc or Aluminum Coated) Corrugated Steel Pipe for Underdrain
Polyvinylchloride (PVC) Perforated Pipe

605.04 Underdrain Construction.

- (a) Underdrain, Type B. The trench shall be excavated to the required width and depth and a bed of the specified granular material, 75 mm [3 inches] in depth, prepared in the trench. One Hundred Fifty millimeter [Six inch] perforated pipe shall be laid on this bed with the perforations as shown on the Standard Detail plans.

After the pipe has been firmly bedded and joints securely connected, it will be inspected before any backfill is placed. The remaining backfill shall be granular material meeting the same requirements as that used for bedding the pipe.

For underdrain placed under areas of proposed pavement, the material shall be placed in 200 mm 8 inch layers, loose measure and thoroughly compacted except that the initial layer of backfill around the pipe may be placed in a layer not exceeding 300 mm [12 inches]. For underdrains placed under areas not proposed to be paved, the initial layer of backfill shall not exceed 300 mm [12 inches] and the remaining material may be placed in one lift to the elevation of the subgrade and compacted with heavy rubber tired or vibratory compaction equipment to the satisfaction of the Engineer.

The upstream end of all completed underdrain pipe shall be sealed with cement mortar or other acceptable material. Care shall be taken that soil does not enter the pipe. Pipe so contaminated before backfilling shall be removed, cleaned and re-laid.

- (b) Underdrain, Type C. The trench shall be excavated to the width and depth as determined by the size and depth of the pipe to be installed.

The perforated pipe shall be laid to line and grade centered on the bottom of the trench with the perforations as shown on the Standard Detail plans.

After the pipe has been firmly bedded and all joints securely connected it will be inspected before any backfill is placed. The backfill shall be placed in accordance with Subsection 603.08 and as shown on the Standard Detail plans using the materials specified.

When Underdrain Type B or Underdrain Type C is constructed, backfill material beyond the underdrain trench lateral limits designated on the plans shall be material conforming to the requirements of Granular Borrow, Underwater Backfill. Material within the underdrain trench limits shall conform to the requirements of the type underdrain being constructed. The Contractor shall take precautions to prevent the underdrain backfill material from becoming contaminated with clay, silts, organic matter or other foreign matter. Methods of placing backfill material shall be limited to the use of equipment which will place material directly into the trench. Pushing material into the trench will not be allowed.

When underdrain is to be constructed in embankment fill, the excavation for the trench shall be done after the embankment has been completed to subgrade elevation.

605.05 Underdrain Outlets. Trenches for underdrain outlets shall be excavated to the required width and depth. These outlets shall be metal pipe of the same size and wall thickness used in the underdrain, except that the perforations may be omitted.

The pipe shall be laid in the trench with all ends firmly joined by the applicable methods and means. After inspection and approval of the pipe installation, the trench shall be backfilled with suitable material in layers and compacted as provided for in Subsection 603.08.

605.06 Method of Measurement. Underdrain and underdrain outlets will be measured by the length in meters [linear feet] along the centerline of underdrains and underdrain outlets of the types and sizes completed and accepted.

When elbows, tees, wyes or other special fittings are required in underdrain, each fitting shall be included for payment as one additional meter [three additional linear feet] of the largest pipe line involved.

605.07 Basis of Payment. The accepted quantities of underdrains and underdrain outlets will be paid for at the contract unit price per meter [linear foot] of each type and size specified complete in place. Outlet pipe for Underdrain, Type C will be paid for under Section 603 -- Pipe Culverts and Storm Drains.

Within and beyond the trench limits, backfill, couplings and bands and other related items will not be paid for separately, but shall be considered included in the unit bid price for the type of underdrain being installed.

Excavation will be measured and paid for as provided in Section 206 -- Structural Excavation. No allowance for payment will be made for excavating or material excavated beyond the horizontal dimensions shown for Underdrain, Type B or Underdrain, Type C.

Payment will be made under:

Pay Item	Pay Unit
605.09 150 mm [6 inch] Underdrain Type B	meter [Linear Foot]
605.10 150 mm [6 inch] Underdrain Outlet	meter [Linear Foot]
605.11 300 mm [12 inch] Underdrain Type C	meter [Linear Foot]
605.12 375 mm [15 inch] Underdrain Type C	meter [Linear Foot]

605.13	450 mm [18 inch] Underdrain Type C	meter [Linear Foot]
605.14	525 mm [21 inch] Underdrain Type C	meter [Linear Foot]
605.15	600 mm [24 inch] Underdrain Type C	meter [Linear Foot]
605.17	750 mm [30 inch] Underdrain Type C	meter [Linear Foot]
605.18	900 mm [36 inch] Underdrain	meter [Linear Foot]

SECTION 606 -- GUARDRAIL

606.01 Description. This work shall consist of furnishing and installing guardrail components in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or as established. The types of guardrail are designated as follows:

- Type 3-Galvanized steel "w" beam, wood posts or galvanized steel posts.
- Type 3a-Galvanized steel "w" beam, wood posts.
- Type 3aa-Corrosion resistant steel "w" beam, wood posts.
- Type 3b-Galvanized steel "w" beam, galvanized steel posts.
- Thrie Beam-Galvanized steel thrie beam, wood posts or galvanized steel posts.

Median barriers shall consist of two beams of the above types, mounted on single posts. Except for thrie beam, median barriers may include rub rails when called for.

MATERIALS

606.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Timber Preservative	708.05
Metal Beam Rail	710.04
Guardrail Posts	710.07
Guardrail Hardware	710.08

Guardrail components shall meet the applicable standards of "A Guide to Standardize Highway Barrier Rail Hardware" prepared and approved by the AASHTO-AGC-ARTRA Joint Cooperative Committee, Technical Bulletin Number 268-B.

Posts for guardrail delineators shall be "U" channel steel, 2.44 m [8 feet] long, 3.72 kg/m [2½ pounds per linear foot] minimum and have 9.5 mm [3/8 inch] round holes, 25 mm [1 inch] center to center for a minimum distance of 610 mm [2 feet] from the top of the post.

Single wood post shall be of cedar, white oak or tamarack, well seasoned, straight and sound and have been cut from live trees. The outer and inner bark shall be removed and all knots trimmed flush with the surface of the post. Posts shall be uniform taper and free of kinks and bends.

Single steel post shall conform to the requirements of Subsection 710.07(b).

Single steel pipe post shall be galvanized, seamless steel pipe conforming to the requirements of ASTM A120, Schedule No. 40, Standard Weight.

CONSTRUCTION REQUIREMENTS

606.03 Posts. Posts for guardrail shall be set plumb in holes or they may be driven if suitable driving equipment is used to prevent battering and distorting the post. When posts are driven through pavement, the damaged area around the post shall be repaired with approved bituminous patching. Damage to lighting and signal conduit and conductors shall be repaired by the Contractor.

When set in holes, posts shall be on a stable foundation and the space around the posts backfilled in layers with suitable material, thoroughly tamped.

Guardrail delineator posts shall be set plumb with the outstanding legs of the channel facing the oncoming traffic. Posts which become bent or otherwise damaged shall be removed and replaced with new posts.

Single wood posts shall be set plumb in holes and backfilled in layers with suitable material, thoroughly tamped. The elevation and shape of the top will be designated by the Engineer. The posts, that are not pressure treated, shall be painted two coats of good quality oil base exterior house paint.

Single steel posts shall be set plumb in holes as specified for single wood posts or they may be driven if suitable driving equipment is used to prevent battering and distorting the post.

606.04 Rails. Brackets and fittings shall be placed and fastened as shown on the plans. Rail beams shall be erected and aligned to provide a smooth, continuous barrier. Beams shall be lapped with the exposed end away from approaching traffic.

End assemblies shall be installed as shown on the plans and shall be securely attached to the rail section and end post.

All bolts shall be of sufficient length to extend beyond the nuts but not more than 13 mm [1/2 inch]. Nuts shall be drawn tight.

606.045 Offset Brackets. Offset brackets shall be of the same material as the posts specified except when an alternative composite material is substituted. The same material is to be provided for the entire project unless otherwise specified.

606.05 Shoulder Widening. At designated locations the existing shoulder of the roadway shall be widened as shown on the plans. All grading, paving, seeding and other necessary work shall be in accordance with the Specifications for the type work being done.

606.06 Mail Box Post. Single wood post shall be installed at the designated location for the support of the mail box. Attachment of the mail box to the post will be the responsibility of the home or business owner.

606.07 Abraded Surfaces. All galvanized surfaces of new guardrail and posts which have been abraded so that the base metal is exposed and the threaded portions of all fittings and fasteners and cut ends of bolts shall be cleaned and painted with two coats of approved rust resistant paint.

606.08 Method of Measurement. Guardrail will be measured by the meter [linear foot] from center to center of end posts along the gradient of the rail except where end connections are made to masonry or steel structures, in which case measurement will be as shown on the plans.

Terminal section, sloped end, twisted end section, breakaway cable terminal and single post will be measured by each unit of the kind specified and installed. Twisted end section will be measured by the unit for each 7.62 m [25 foot] long installation, complete and installed.

Widened shoulder will be measured as a unit of grading within the limits shown on the plans.

Excavation in solid rock for placement of posts will be measured by the cubic meter [cubic yard] determined from the actual depth of the hole and a hypothetical circle diameter of 600 mm [2 feet].

606.09 Basis of Payment. The accepted quantities of guardrail will be paid for at the contract unit price per meter [linear foot] for the type specified, complete in place. Terminal section, buffer end, flared end, twisted end section, bridge connection and single post will be paid for at the contract unit price each for the kind specified complete in place.

Breakaway cable terminal will be paid for at the contract price each, complete in place which price shall be full payment for furnishing and installing all components including the terminal section, posts, brackets, "w" rail, cable foundation posts, plates and for all incidentals necessary to complete the installation within the limits as shown on the Standard Detail Sheets. Such payment shall also be full compensation for furnishing all material, excavating, backfilling holes, assembling and all incidentals necessary to complete the work except that payment for excavation for posts or anchorages in solid ledge rock, will be made under Pay Item 206.07.

Anchorage to bridge end posts will be part of the bridge work. Connections thereto will be considered included in the unit bid price for guardrail.

Guardrail to be placed on a radius of curvature of 45 m [150 feet] or less will be paid for under the designated radius pay item for the type guardrail being placed.

Widened shoulder will be paid for at the contract unit price each complete in place and will be full compensation for furnishing and placing, grading and compaction of aggregate subbase.

Payment will be made under:

Pay Item	Pay Unit
606.15 Guardrail Type 3a-Single Rail	meter [Linear Foot]
606.151 Guardrail Type 3aa-Single Rail	meter [Linear Foot]
606.16 Guardrail Type 3a-Double Rail	meter [Linear Foot]
606.17 Guardrail Type 3b-Single Rail	meter [Linear Foot]
606.171 Guardrail Type 3b-Single Rail with Rub Rail	meter [Linear Foot]
606.173 Bridge Connection	Each
606.18 Guardrail Type 3b-Double Rail	meter [Linear foot]
606.181 Guardrail Type 3b-Double Rail with Rub Rail	meter [Linear Foot]
606.19 Guardrail Type 3a-4.5 m [15 foot] radius and less	meter [Linear Foot]
606.191 Guardrail Type 3aa-4.5 m [15 foot] radius and less	meter [Linear Foot]
606.20 Guardrail Type 3a-over 4.5 m [15 foot] radius and less	meter [Linear Foot]
606.201 Guardrail Type 3aa-over 4.5 m [15 foot] radius	meter [Linear Foot]
606.21 Guardrail Type 3b-4.5 m [15 foot] radius	meter [Linear Foot]
606.22 Guardrail Type 3b-over 4.5 m [15 foot] radius	meter [Linear Foot]
606.25 Terminal Connector	Each
606.257 Terminal Connector-Thrie Beam	Each
606.262 Twisted End Section-Guardrail Type 3a	Each
606.263 Twisted End Section-Guardrail Type 3a	Each
606.265 Terminal End-Single Rail-Galvanized Steel	Each
606.266 Terminal End-Single Rail-Corrosion Resistant Steel	Each
606.275 Terminal End-Double Rail-Galvanized Steel	Each
606.276 Terminal End-Double Rail-Corrosion Resistant Steel	Each
606.35 Guardrail Delineator Post	Each
606.47 Single Wood Post	Each
606.48 Single Galvanized Steel Post	Each
606.49 Single Corrosion Resistant Steel Post	Each
606.50 Single Steel Pipe Post	Each
606.55 Guardrail Type 3-Single Rail	meter [Linear Foot]
606.551 Guardrail Type 3-Single Rail with Rub Rail	meter [Linear Foot]
606.56 Guardrail Type 3-Double Rail	meter [Linear Foot]
606.561 Guardrail Type 3-Double Rail with Rub Rail	meter [Linear Foot]
606.59 Guardrail Type 3-4.5 m [15 foot] radius and less	meter [Linear Foot]
606.60 Guardrail Type 3-over 4.5 m [15 foot] radius and less	meter [Linear Foot]
606.621 Twisted End Section-Guardrail Type 3	Each
606.64 Guardrail Thrie Beam-Double Rail	meter [Linear Foot]
606.65 Guardrail Thrie Beam-Single Rail	meter [Linear Foot]
606.66 Terminal End Thrie Beam	Each
606.67 Buffer End Thrie Beam	Each
606.68 Buffer End Thrie Beam Modified	Each
606.69 Flared End Thrie Beam	Each
606.70 Transition Section-Thrie Beam	Each
606.71 Guardrail Thrie Beam-4.5 m [15 foot] radius and less	meter [Linear Foot]
606.72 Guardrail Thrie Beam-greater than 4.5 m [15 foot] radius	meter [Linear Foot]
606.73 Guardrail Thrie Beam-Single Rail Bridge Mounted	meter [Linear Foot]
606.74 Guardrail Type 3-Single Rail Bridge Mounted	meter [Linear Foot]
606.751 Widen Shoulder for Breakaway Cable Terminal	Each
606.77 Breakaway Cable Terminal	Each

SECTION 607 -- FENCES

607.01 Description. This work shall consist of the construction of fence and gates in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer. The construction of fencing shall include the assembly and erection of all parts and materials including barways and gates complete at the locations shown on the plans or as directed.

MATERIALS

607.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Barbed Wire	710.01
Woven Wire	710.02
Chain Link Fabric	710.03
Cedar Rail Fence	710.05
Fence Posts and Braces	710.06

Bars for barways shall be of eastern hemlock, northern white pine, Norway pine, spruce, cedar or tamarack, equal in quality to the wood posts. The bark shall be removed and all knots hewn flush.

Metal gates shall be of galvanized steel.

Staples shall be of galvanized or aluminum coated steel.

Concrete for anchoring metal posts, metal braces and wooden gate posts shall meet the requirements of Section 502 -- Structural Concrete, except air entraining will not be required. The class of concrete shall be optional.

Drive anchors shall be an approved anchorage consisting of two steel angles driven diagonally into the ground through metal clamps bolted to the post. All parts shall be galvanized.

CONSTRUCTION REQUIREMENTS

607.03 General. The Contractor shall perform clearing and grubbing necessary to construct the fence to the required grade and alignment.

Posts shall be spaced as called for on the plans except that a variation of 600 mm [2 feet] back or ahead on line may be allowed at approved locations. The tops of posts shall be set to the required grade and alignment. Cutting off the posts may be allowed with approval.

Posts for cedar rail fence shall be set plumb in drilled or hand dug holes. After posts are placed, rails installed and the posts aligned, the post holes shall be backfilled. The completed fence shall have the tops of the posts at uniform height above ground following the gradient of the ground.

Posts for woven wire fence and barbed wire fence shall be braced with Type I or Type II bracing at designated location as hereafter specified. Type I bracing shall include diagonal brace and 1 post of the designated size. Type II bracing shall include 2 diagonal braces and 1 post of the designated size.

When the plans require posts or braces to be anchored into the soil, concrete anchors or metal drive anchors shall be used. If concrete is used, temporary guys to hold the posts in position shall be installed until the concrete has set. Unless otherwise permitted, no material shall be installed on posts or strain placed on guys and bracing set in concrete until 48 hours after the concrete has been placed.

If metal drive anchors are used they shall be installed according to the manufacturer's instructions so all parts will be below the ground surface. One drive anchor shall be used on line posts; 2 drive anchors shall be used on bracing assemblies, Type I and Type II. Where 2 drive anchors are used they shall be placed perpendicular to each other.

Backfilling shall be with earth placed in 200 mm [8 inch] layers, loose measure and each layer thoroughly tamped.

Metal posts to be set in solid rock shall be placed in drilled holes and grouted with a cement grout composed of 1 part portland cement and 2 parts sand mixed with water.

All surplus material and other debris shall be removed and disposed of.

607.04 Woven Wire or Barbed Wire Fencing. Wood posts shall be set plumb in holes dug to full depth. Metal posts shall be set plumb by an approved post driver. Posts which are bent or otherwise damaged shall be removed and replaced.

- (a) Bracing. At changes in horizontal alignment in excess of 30 degrees, bracing will be required. At changes in horizontal alignment of 15 degrees to 30 degrees, bracing may be called for on the plans or required by the Engineer. At changes in horizontal alignment angles of less than 15 degrees, bracing will not be required except at intervals of 200 m [660 feet].

In depressions where tension in the fencing may cause lifting, the post will require bracing.

End, corner, gate, barway and intermediate posts shall be braced and anchored as shown on the Standard Detail sheets.

If metal posts are to be placed in concrete, the concrete shall be allowed to set before the space around the base is backfilled. Backfilling shall be with satisfactory

material thoroughly tamped. If directed, the Contractor shall place a minimum of 150 mm [6 inches] of gravel in the bottom of the post hole.

- (b) Gates. All gates and the bracing assemblies at gates shall be constructed of metal.
- (c) Barways. Barways shall be constructed of posts corresponding to the type of fence posts used. Wood cross bars shall be furnished.
- (d) Erection of Fabric or Wire. Fabric or wire shall be stretched taut. Each strand of barbed wire shall be attached to wood posts with staples. Top and bottom strands of woven wire shall be attached to each post and alternate interior strands of woven wire fencing shall be attached to alternate posts. Staples shall not be driven into line posts so as to restrict the horizontal movement of wire except at corner posts, end posts and bracing where staples shall be fully driven. When attaching fencing to metal posts, approved stay fasteners shall be used.

Except as otherwise provided, splicing wire will be permitted at posts only with each horizontal strand of wire wrapped completely around the post. The wire strand shall be fastened by winding the wire about the same strand where it leads to the post. This type of fastening shall be used at each end post, corner post and gate post and at barway posts. Other devices designed specifically to splice fencing wire may be used, subject to approval.

607.05 Chain Link Fence. Foundations for posts for chain link fence shall be cast-in-place portland cement concrete placed in approved forms or shall be approved metal drive anchors. If wood forms are used, they shall be removed before backfilling. If fiber forms are used they need not be removed.

- (a) Braces. Fences less than 1.8 m [6 feet] in height that are installed with a top rail shall not require any brace rails. Fences less than 1.8 m [6 feet] in height installed without a top rail and all fences with heights of 1.8 m [6 feet] or more shall have brace rails installed midway between the top and bottom of the fabric as shown on the plans. Braces shall be securely fastened to the posts then trussed from the line post to the base of the end, intermediate or corner post with a 10 mm [3/8 inch] diameter truss rod and tightened. At changes in horizontal alignment of less than 15 degrees, bracing will not be required except at intervals of 100 m [330 feet]. At changes in alignment of 15 degrees to 30 degrees, bracing may be required as called for on the plans or requested. At changes in alignment in excess of 30 degrees, bracing will be required. One brace assembly shall be furnished with each end or gate post and two assemblies with each corner or intermediate post and at grade changes specified above.
- (b) Gates. Where gates are required for chain link fence they shall be constructed of metal.
- (c) Erection of Chain Link Fabric. The grade of fence shall be approximately parallel with the grade of the ground. When directed, abrupt depressions shall be filled.

Top rails when required, shall pass through post caps and be securely fastened to end, corner, brace and gate posts. Joints in top rails shall be made with expansion

sleeve couplings. On curves with a radius of less than 150 m [500 feet] the top rail shall be bent to the arc.

The fabric shall be pulled taut and the ends attached to the posts with stretcher bars and bands or other approved devices. When required, wire fabric shall be joined by weaving a single strand of mesh wire into the ends of the rolls to form a continuous mesh.

607.06 Methods of Measurement. Fence will be measured by the meter [linear foot] accepted in place. Measurement will be along the gradient of the fence from outside to outside of end posts for each continuous run of fence and shall include fence at bracing assemblies but shall not include space at gates and barways. Gates, barways and bracing assemblies will be measured by the unit of the size and type specified. Excavation in rock for placement of fence posts in drilled holes will be measured by the cubic meter [cubic yard] determined from the actual depth of the drilled hole in the rock and a hypothetical circle diameter of 600 mm [2 feet].

607.07 Basis of Payment. The accepted quantities of fence will be paid for at the contract unit price per meter [linear foot] of the type and size specified complete in place. Barways, gates and bracing assemblies will be paid for at the contract unit price for each type specified complete in place. Payment shall be full compensation for furnishing and assembling all materials, for excavating and backfilling holes, and for all incidentals necessary to complete the work except that in rock, payment for drilled holes will be made under Pay Item 206.07. Excavation of earth to exposed rock shall be incidental to the several items for erection of the fence.

Payment for bracing assemblies shall include furnishing and installing the various larger size and longer length posts, diagonal bracing, ties, anchors and all incidental hardware necessary to complete the type of assembly required, all as shown on the Standard Detail sheets. At gateways, payment will be made for bracing assemblies and there will be no separate payment for the gate posts. All extra costs incurred for furnishing and installing the oversize posts at gateways shall be considered included with the various contract items.

Clearing or removal of trees, stumps or boulders, required to install the fence shall be included in the work of the respective pay items of this section.

Payment will be made under:

Pay Item	Pay Unit
607.08 Woven Wire Fence-Wood Posts	meter [Linear Foot]
607.09 Woven Wire Fence-Metal Posts	meter [Linear Foot]
607.10 Barbed Wire Fence-Wood Posts	meter [Linear Foot]
607.11 Barbed Wire Fence-Metal Posts	meter [Linear Foot]
607.12 Barway-Wood Posts	Each
607.13 Barway-Wood Posts	Each
607.14 Walk Gateway 1.2 m [4 foot]-Metal	Each
607.15 Drive Gateway 4.9 m [16 foot]-Metal	Each
607.16 Chain Link Fence-1.2 m [4 foot]	meter [Linear Foot]
607.163 Chain Link Fence-1.2 m [4 Foot]-PVC Coated	meter [Linear Foot]
607.165 Chain Link Fence-1.2 m [4 Foot]-without Top Rail	meter [Linear Foot]

607.17	Chain Link Fence-1.8 m [6 foot	meter [Linear Foot]
607.173	Chain Link Fence - 1.8 m [6 Foot]-PVC Coated	meter [Linear Foot]
607.175	Chain Link Fence-1.8 m [6 Foot]-without Top Rail	meter [Linear Foot]
607.18 through 607.21 Vacant		
607.22	Cedar Rail Fence	meter [Linear Foot]
607.23	Chain Link Fence Gate	Each
607.24	Remove and Reset Fence	meter [Linear Foot]
607.25	Remove and Reset Chain Link Fence	meter [Linear Foot]
607.26 through 607.29, Vacant		
607.30	Bracing Assembly Type I-Wood Posts	Each
607.31	Bracing Assembly Type II-Wood Posts	Each
607.32	Bracing Assembly Type I-Metal Posts	Each
607.33	Bracing Assembly Type II-Metal Posts	Each
607.34	Bracing Assembly Chain Link Fence	Each
607.35	Bracing Assembly Chain Link Fence-PVC Coated	Each

SECTION 608 -- SIDEWALKS

608.01 Description. This work shall consist of the construction of hot bituminous paved, brick paved or portland cement concrete paved sidewalks, plain or reinforced as specified, in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established. This work does not include sidewalks on bridges.

MATERIALS

608.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Preformed Expansion Joint Filler	705.01
Welded Steel Wire Fabric	709.02

Portland cement concrete for sidewalks shall meet the requirements of Section 502 -- Structural Concrete, Class A.

Bituminous paved sidewalks shall meet the requirements of Section 403 -- Hot Bituminous Pavement.

Brick paved sidewalks shall meet the requirements of Section 431 -- Brick Pavement.

CONSTRUCTION REQUIREMENTS

608.03 Portland Cement Concrete Sidewalks.

- (a) Excavation. Excavation shall be to the depth and width that will permit the installation and bracing of the forms. The foundation shall be shaped and compacted to a firm even surface conforming to the section shown on the plan. All soft and yielding material shall be removed and replaced with acceptable material.
- (b) Forms. Forms shall be of wood or metal and shall extend for the full depth of the concrete. All forms shall be true, free from warp and of sufficient strength to resist the pressure of the concrete without springing. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal.
- (c) Placing Concrete. The foundation shall be thoroughly moistened immediately prior to placing the concrete. The proportioning, mixing and placing of the concrete shall be in accordance with the requirements of Section 502 -- Structural Concrete.
- (d) Finishing. The surface shall be finished with a wooden float which shall be moved in a circular motion to produce a shell-like pattern. No plastering of the surface with mortar will be permitted.

All outside edges of the slab and all joints shall be rounded with a 6 mm [1/4 inch] radius edging tool.

- (e) Joints. Joints shall be located as shown on the plans. Slabs shall be placed alternately and the joints coated with an approved bituminous material before placing the adjacent slab.

When a concrete sidewalk is constructed adjacent to a curb, building, retaining wall or other fixed structure, a 6 mm [1/4 inch] thick preformed joint filler shall be used between the slab and the structure.

- (f) Curing. Concrete shall be cured for at least 72 hours. Curing shall be by moist burlap or mats, white pigmented curing compound or by other approved methods. During the curing period, all traffic, both pedestrian and vehicular, shall be excluded. Vehicular traffic shall be excluded for such additional time as may be directed.

608.04 Hot Bituminous Sidewalk.

- (a) Excavation. Excavation shall be to the required depth and width. The foundation shall be shaped and compacted to a firm even surface conforming to the section shown on the plan. All soft and yielding material shall be removed and replaced with acceptable material.
- (b) Base Course. Base course material shall be placed as shown on the plans and each layer thoroughly compacted.
- (c) Placing Bituminous Sidewalk Material. Bituminous sidewalk material shall be placed on the compacted base course in two courses to provide the required depth when rolled. Compaction shall be by a power roller having a minimum total weight of 900 kg [2,000 pounds] with a minimum of 1160 kg/m [65 pounds per inch] of width of the drive roll or by satisfactory power vibratory compaction equipment. In areas inaccessible to other equipment, hand tamping will be permitted. In any case the bituminous sidewalk material shall be uniformly compacted.

608.41 Brick Sidewalk

- (a) Excavation. Excavation shall be to the required depth and width and the foundation shaped and compacted to a firm even surface conforming to the section shown on the plan. All soft and yielding material shall be removed and replaced with acceptable material.
- (b) The base coarse and hot bituminous pavement shall conform to the requirements of Section 431 -- Brick Pavement.

608.05 Method of Measurement. Portland cement concrete sidewalks and brick sidewalk will be measured by the square meter [square yard] of finished surface. Bituminous concrete sidewalks will be measured by the megagram [ton] of bituminous mixture placed.

608.06 Basis of Payment. The accepted quantities of sidewalk will be paid for at the contract unit price per square meter [square yard] for portland cement concrete sidewalk and brick sidewalk, per megagram [ton] for hot bituminous sidewalk and cubic meter [cubic yard] for base course material complete in place. Excavation will be paid for under Section 203 -- Excavation and Embankment. Expansion joint material, joint filler and other related items will not be paid for separately but the cost thereof shall be included in the cost of the sidewalk. Base and subbase material will be paid for under Section 304 -- Aggregate Base and Subbase Course. Bituminous mixture for sidewalk will be paid for under Section 403 -- Hot Bituminous Pavement.

Payment for reinforcement will be considered included in the contract unit price for reinforced concrete sidewalk.

Payment will be made under:

Pay Item	Pay Unit
608.07 Plain Concrete Sidewalk	square meter [Square Yard]
608.08 Reinforced Concrete Sidewalk	square meter [Square Yard]
608.10 Brick Sidewalk (Remove and Rebuild)	square meter [Square Yard]
608.15 Brick Sidewalk with Bituminous Base	square meter [Square Yard]
608.16 Brick Driveway Aprons with Bituminous Base	square meter [Square Yard]

SECTION 609 -- CURBING

609.01 Description. This work shall consist of furnishing and installing curb or edging, or removing and relaying existing curbing, or edging on highways and bridges in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established. The types of curb are designated as follows:

- Type 1-Stone curbing of quarried granite stone
- Type 2-Precast Portland Cement Concrete Curbing
- Type 3-Bituminous curbing
- Type 5-Stone edging of quarried granite stone

MATERIALS

609.02 Materials. Except as provided below, the materials used shall meet the requirements of the following Subsections of Division 700 -- Materials:

Joint Mortar	705.02
Reinforcing Steel	709.01
Portland Cement	712.03
Concrete for Concrete Curb	
Stone Curbing and Edging	712.04
Epoxy Resin	712.35
Bituminous Curbing	712.36

Circular curb, terminal sections and transition sections shall be in reasonably close conformity with the shape and dimensions shown on the plans and to the applicable material requirements herein for the type of curb specified.

Dowels shall be reinforcing steel deformed bars.

CONSTRUCTION REQUIREMENTS

609.03 Vertical Stone Curb, Terminal Section and Transition Sections.

- (a) Installation. The curb stone shall be set on a compacted foundation so that the front top arris line conforms to the lines and grades required. The foundation shall be prepared in advance of setting the stone by grading the proper elevation and shaping to conform as closely as possible to the shape of the bottom of the stone. The required spacing between stones shall be assured by the use of an approved spacing device to provide an open joint between stones of at least 6 mm [1/4 inch] and no greater than 15 mm [5/8 inch].
- (b) Backfilling. All remaining spaces under the curb shall be filled with approved material and thoroughly hand tamped so the stones will have a firm uniform bearing on the foundation for the entire length and width. Any remaining excavated areas surrounding the curb shall be filled to the required grade with approved materials. This material shall be placed in layers not exceeding 200 mm [8 inches] in depth, loose measure and thoroughly tamped.

When backfill material infiltrates through the joints between the stones, small amounts of joint mortar or other approved material shall be placed in the back portion of the joint to prevent such infiltrating.

- (c) Protection. The curb shall be protected and kept in good condition. All exposed surfaces smeared or discolored shall be cleaned and restored to a satisfactory condition or the curb stone removed and replaced.
- (d) Curb Inlets. Curb placed adjacent to curb inlets shall be installed with steel dowels cemented into each stone with epoxy grout as shown on the Standard Detail sheets.

The epoxy grout shall be used in accordance with the manufacturer's instructions. The grout shall be forced into the hole, after which the dowel shall be coated with grout for one-half its length and inserted into the grout filled hole. The hole shall be completely filled with grout around the dowel. All tools and containers must be clean before using.

609.04 Bituminous Curb.

- (a) Preparation of base. Prior to placing the curb, the foundation course shall be thoroughly cleaned of all foreign and objectionable material. String or chalk lines shall be positioned on the prepared base to provide guide lines. The foundation shall be uniformly painted with tack coat as specified under Section 410 -- Bituminous Surface Treatment.
- (b) Placing. The curb shall be placed by an approved power operated extruding type machine using the shape mold called for. A tight bond shall be obtained between the base and the curb. The Engineer may permit the placing of curbing by other than mechanical curb placing machines when short sections or sections with short

radii are required. The resulting curbing shall conform in all respects to the curbing produced by the machine.

- (c) Sealing. The curb shall be sealed with bituminous sealing compound, when directed, in accordance with Section 612 -- Bituminous Sealing. Before sealing, the curb shall be clean, dry and shall have reached the ambient temperature.
- (d) When required, the curb shall be painted and coated with glass beads in accordance with Section 627 -- Pavement Marking. Curb designated to be painted shall not be sealed with bituminous sealing compound before the curb is painted.
- (e) Acceptance. Curb may be accepted or rejected on the basis of appearance in regard to texture, alignment or both. All damaged curb shall be removed and replaced at the Contractor's expense.
- (f) Polyester fibers shall be uniformly incorporated into the dry mix at a rate of 0.25 percent of the total batch weight. Certification shall be provided from the supplier with each shipment meeting the following requirements:

Average Length	6.35 mm $\pm$ 0.127 [0.25 inch $\pm$ 0.005]
Average Diameter	20 m $\pm$ 2.5 [0.0008 inch $\pm$ 0.0001]
Specific Gravity	1.32-1.40
Melting Temperature	250 °C [480 °F] Minimum
Color	Natural (White)

609.05 Portland Cement Concrete Curb, Terminal Sections and Transition Sections.

- (a) Installation. The curb shall be set on firm foundation of gravel so that the front top arris line conforms to the line and grade required. The curbs shall be fitted together to form an open joint of at least 6 mm [1/4 inch] and no greater than 15 mm [5/8 inch] in width.
- (b) Backfilling. All spaces under the curb shall be filled with gravel and firmly tamped so that they will have firm uniform bearing on the foundation for the entire length and width of the curb. Any remaining excavated areas surrounding the curb shall be filled to the required grade with approved materials. This material shall be placed in layers not exceeding 200 mm [eight inches] in depth, loose measure, and shall be thoroughly tamped.
- (c) Protection. The curb shall be protected and kept in good condition, particular care being taken to prevent any discoloration of exposed surfaces. All exposed surface smeared or discolored shall be cleaned and restored to a satisfactory condition or the curb unit shall be replaced.

- (d) Curb Inlets. Curb placed adjacent to curb inlets shall be installed with steel dowels cemented into each stone with epoxy grout as shown on the Standard Detail Sheets.

The epoxy grout shall be used in accordance with the manufacturer's instructions. The grout shall be forced into the hole, after which the dowel shall be coated with grout for one-half its length and inserted into the grout filled hole. The hole shall be completely filled with grout around the dowel. All tools and containers must be cleaned before using.

609.06 Stone Edging. The curb shall be installed, backfilled and protected in accordance with Subsection 609.03, except as follows:

- (a) Slope. The edging shall be set on a slope as shown on the plans or as directed.
- (b) Joints. Joints shall be open and not greater than 40 mm [1½ inch] in width.

609.07 Stone Bridge Curb.

- (a) Installation. Each stone and the bed upon which it is to be placed shall be cleaned and thoroughly wetted with water prior to placing the mortar for bedding and setting the stone. The stone shall be set on a fresh bed of joint mortar and well bedded before the mortar has set so that the front top arris line conforms to the line and grade required. Whenever temporary supporting wedges or other devices are used in setting the stones, they shall be removed before the mortar in the bed has become set, and the holes left by them shall be filled with mortar. Concrete behind the stones shall not be placed until the stones have been in place at least two days. Bedding and pointing mortar for joints shall be cured as required under Section 502 -- Structural Concrete.
- (b) Joints. Vertical joints shall be 13 mm [1/2 inch] in width plus or minus 3 mm [1/8 of an inch]. Whenever possible, the face and top of the joint shall be pointed with joint mortar to a depth of 40 mm [1½ inches], before the bedding mortar has set. Joints which cannot be so pointed shall be prepared for pointing by raking them to a depth of 40 mm [1½ inches] before the mortar has set. Joints not pointed at the time the stone is laid shall be thoroughly wetted with clean water and filled with mortar. The mortar shall be well driven into the joint and finished with an approved pointing tool, flush with the pitch line of the stones.

609.08 Resetting Stone or Portland Cement Concrete Curb, Including Terminal Sections and Transitions.

- (a) Removal of Curbing. The Contractor shall carefully remove and store curb specified on the plans or designated for resetting. Curb damaged or destroyed, as a result of the Contractor's operations or because of his failure to store and protect it in a manner that would prevent its loss or damage, shall be replaced with curbing of equal quality at the Contractor's expense.
- (b) Excavation. Necessary excavation shall be made to the required depth and the base upon which the curb is to be set shall be compacted to a firm, even surface. All soft

and unsuitable material shall be removed and replaced with suitable material which shall be thoroughly compacted.

- (c) Setting Curb. The curb shall be set and backfilled in accordance with Subsection 609.03, 609.05 or 609.06 whichever is applicable.
- (d) Cutting and Fitting. Cutting or fitting necessary in order to install the curbing at the locations directed shall be done by the Contractor.

609.09 Method of Measurement. Curb, both new and reset, will be measured by the meter [linear foot] along the front face of the curb at the elevation of the finished pavement, complete in place and accepted. Curb inlets at catch basins, including doweling, will not be measured for payment but shall be considered included in the cost of the catch basin. New transition sections and terminal curb will be measured by the unit. Reset transition sections and terminal curb will be included in the measurement for resetting curb.

609.10 Basis of Payment. The accepted quantities of curbing will be paid for at the contract unit price per meter [linear foot] for each kind and type of curbing as specified.

Payment for terminal curb shall include only that portion of the curbing modified for installation at ends of curb runs shown on the Standard Detail Sheets. Curb adjacent to terminal ends shall be paid for at the contract unit price per meter [linear foot] for the type of curb installed.

Vertical Curb Type 1 and Type 2 required to be placed on a radius of 20 m [60 feet] or less, will be paid for as Vertical Curb Type 1-Circular.

Curb, Type 5 required to be placed on a radius of 10 m [30 feet] or less will be paid for as Curb Type 5-Circular.

There will be no separate payment for cement, reinforcing steel, anchors, tack coat, drilling for and grouting anchors, pointing and bedding of curbing, and for cutting and fitting, but these will be considered included in the work of the related curb.

Necessary excavation for installing new or reset curbing will not be paid for directly, but shall be considered to be included in the appropriate new or reset curb pay item. Base and Subbase material will be paid for under Section 304 -- Aggregate Base and Subbase Course.

Payment will be made under:

Pay Item	Pay Unit
609.11 Vertical Curb Type 1	meter [Linear Foot]
609.12 Vertical Curb Type 1-Circular	meter [Linear Foot]
609.13 Vertical Bridge Curb Type 1	meter [Linear Foot]
609.131 Vertical Bridge Curb Type 1A	meter [Linear Foot]
609.132 Vertical Bridge Curb Type 1B	meter [Linear Foot]
609.142 Vertical Bridge Curb Type 1B -Circular	meter [Linear Foot]
609.15 Sloped Curb Type 1	meter [Linear Foot]
609.19 Vertical Curb-Type 2	meter [Linear Foot]

609.20	Vertical Curb-Circular-Type 2	meter [Linear Foot]
609.23	Terminal Curb Type 1	Each
609.234	Terminal Curb Type 1-1.2 m [4 Foot]	Each
609.237	Terminal Curb Type 1-2.1 [7 Foot]	Each
609.244	Terminal Curb-Type 2 -1.2 m [4 Foot]	Each
609.247	Terminal Curb-Type 2 -2.1 m [7 Foot]	
609.26	Curb Transition Section B Type 1	Each
609.31	Curb Type 3	meter [Linear Foot]
609.34	Curb Type 5	meter [Linear Foot]
609.35	Curb-Type 5-Circular	meter [Linear Foot]
609.38	Reset Curb Type 1	meter [Linear Foot]
609.39	Reset Curb Type 2	meter [Linear Foot]
609.40	Reset Curb Type 5	meter [Linear Foot]

SECTION 610 -- STONE FILL, RIPRAP, STONE BLANKET AND STONE DITCH PROTECTION

610.01 Description. This work shall consist of excavating for and constructing a protective covering of stone, with or without grout.

The types of protective covering of stone are designated as follows:

- (a) Stone fill - Machine placed embankment for fill slope
- (b) Plain Riprap - Machine placed stones on earth bedding
- (c) Hand Laid Riprap - Hand placed stones on earth bedding
- (d) Stone Blanket - Machine placed stones around piers and Abutments
- (e) Heavy Riprap - Machine placed stones on earth bedding
- (f) Stone Ditch Protection - Machine placed ditch protection of rock

MATERIALS

610.02 Materials. Materials shall meet the requirements of the following Subsections of Division 700 -- Materials:

Stone Fill	703.25
Plain and Hand Laid Riprap	703.26
Stone Blanket	703.27
Heavy Riprap	703.28
Stone Ditch Protection	703.29

Portland cement concrete for grouting riprap shall conform to the requirements of Section 502 -- Structural Concrete for Class "AA" concrete, except that coarse aggregate will not be required and additional water may be used to form a more workable mix.

CONSTRUCTION REQUIREMENTS

610.031 General. Suitable material removed when excavating for the placing of riprap, stone fill, stone blanket or stone ditch protection shall be used in the formation of embankments, subgrade and for backfilling as shown on the plans or as directed.

610.032 Placing Stones.

- (a) Stone Fill and Stone Blanket. Material for stone fill shall be deposited to provide a compact mass. The exposed slope shall be finished to the line and grade required without special handling or hand work. Material for stone blanket shall be deposited for protection around piers or abutments as shown on the plans. The stones shall be placed individually to form a reasonably compact mass. Spaces between the larger stones shall be filled with stone or spall of suitable size to leave an even surface conforming to the contour required.
- (b) Riprap. Stones for riprap shall be placed upon a slope properly graded and compacted as called for. When required, the bottom of the riprap shall be placed in a trench at the toe of the slope. Plain riprap shall be placed full depth in one operation without special handwork and shall be placed approximately true to the required slope line and grade and be uniform in appearance. Hand laid riprap shall be random rubble, hand laid stones for the full depth placed in one operation to secure interlocking of all face stones and stones placed as backing. Larger stones shall be laid at the base of the slope. The stones shall be laid in close contact with the longer axis perpendicular to the plane of the slope and so as to stagger joints. Except when required to be grouted the openings between the stones in all riprap shall be filled with spall, or rocks securely rammed into place.

Stones for heavy riprap shall be placed to the full depth in one operation without special handwork or machine work upon a properly graded and compacted slope. Above the low water elevation, stones shall be placed to form an approximate uniform surface, free from humps or depressions, with no excessively large stones projecting from the general surface. Loose stones or excessively large stones tending to extend above the average general surface shall be embedded, reoriented or discarded. The openings between stones on the face of heavy riprap shall be filled with spall or small rocks, securely rammed into place.

- (c) Stone Ditch Protection. The ditch shall be excavated below the flow line to allow placement of the rock material to the specified depth. The stone ditch protection shall be placed, full depth, in one operation without special handwork, shall be approximately true to line and grade and shall be uniform in appearance.

610.04 Portland Cement Grout. Portland cement grout shall have a consistency suitable to permit grout to flow readily into the voids between the stones. The grout shall be placed upon the stones and swept into the interstices until all voids between the stones are filled to the full depth of the riprap. After placing, the grout shall be protected from drying for at least 3 days. Grout shall not be placed during freezing weather.

610.05 Method of Measurement. Stone fill, plain riprap, hand laid riprap, stone blanket, heavy riprap and stone ditch protection will be measured by the cubic meter [cubic yard], complete in place, except that when placed under water the quantity may be measured by truck load count with no reduction in volume. Portland cement for riprap grout will be measured by the barrel of portland cement actually used. Riprap grout delivered in transit mix trucks from commercial sources shall be accompanied by a delivery slip in accordance with Subsection 109.01(f).

610.06 Basis of Payment. The accepted quantities of stone fill, plain riprap, hand laid riprap, stone blanket, heavy riprap and stone ditch protection and materials to fill the voids will be paid for at the contract unit price per cubic meter [cubic yard] complete in place. Portland cement for riprap grout will be paid for at the contract unit bid price per barrel of cement which price shall include furnishing all sand, aggregates, water, and for mixing, transporting, placing and curing the grout.

Costs of all required excavation below the slope line for the placement of bedding, riprap, stone fill, stone blanket, stone ditch protection and for furnishing and placing the bedding material itself, will be considered incidental to the contract items and no separate payment will be made.

Payment will be made under:

Pay Item	Pay Unit
610.07 Stone Fill	cubic meter [Cubic Yard]
610.08 Plain Riprap	cubic meter [Cubic Yard]
610.09 Hand Laid Riprap	cubic meter [Cubic Yard]
610.11 Stone Blanket	cubic meter [Cubic Yard]
610.12 Portland Cement for Riprap Grout	Barrel
610.16 Heavy Riprap	cubic meter [Cubic Yard]
610.18 Stone Ditch Protection	cubic meter [Cubic Yard]

SECTION 611 -- SLAB FOR BACKSLOPE PROTECTION

611.01 Description. This work shall consist of slabs of stone or precast concrete placed on backslopes in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established.

MATERIALS

611.02 Materials. Materials shall conform to the requirements specified in the following Subsections of Division 700 -- Materials:

Joint Mortar	705.02
Reinforcing Steel	709.01
Precast Concrete Slab	712.37
Stone Slab	712.38

CONSTRUCTION REQUIREMENTS

611.03 Excavation. The slope behind the slabs shall be carefully graded, by hand if necessary, to avoid disturbing earth beyond the designated limits.

611.04 Placement of Slab. The slabs shall be placed to conform to the required line and grade. They shall be fitted together to form a vertical joint of not less than 5 mm [1/4 inch] and not greater than 20 mm [3/4 inch] wide. The space behind the slabs shall be backfilled with approved granular material thoroughly compacted. Special care shall be taken not to disturb the slabs.

The vertical joints shall be filled with approved caulking compound and neatly smoothed. The surface of the slab shall be protected from all caulking compound.

The slabs shall be protected and kept in good condition with particular care being taken to prevent discoloration of exposed surfaces. All exposed surfaces smeared or discolored shall be cleaned and restored to a satisfactory condition or removed and replaced with a new slab.

Lift holes shall be filled with cement mortar.

611.05 Method of Measurement. Slab for backslope protection will be measured by the square meter [square yard] of slab complete in place, measured parallel to the slope but not to exceed the dimensions shown on the plans or authorized by the Engineer.

611.06 Basis of Payment. The accepted quantity of slab for backslope protection will be paid for at the contract unit price per square meter [square yard] complete in place including caulking of joints.

Excavation to the face of the slab will be measured and paid for as provided in Section 203 -- Excavation and Embankment. Excavation and backfill beyond the face of the slab will be considered incidental to the various contract items and no separate payment will be made.

Payment will be made under:

Pay Item	Pay Unit
611.16 Stone Slab for Backslope Protection	square meter [Square Yard]
611.17 Concrete Slab for Backslope Protection	square meter [Square Yard]

SECTION 612 -- BITUMINOUS SEALING

612.01 Description. This work shall consist of sealing bituminous mix surfaces with emulsified bituminous sealing compound of the specified color, applied at locations shown on the plans or designated.

MATERIALS

612.02 Materials. Bituminous material for sealing shall conform to the requirements of Emulsified Bituminous Sealing Compound, Subsection 702.12.

CONSTRUCTION REQUIREMENTS

612.03 General. The sealing compound shall be applied in 2 coats. The first coat shall be diluted by the addition of up to 50 percent water to a liquid consistency and applied with brooms or other approved methods at a rate of 1.25 to 2.25 L [0.25 to 0.50 gallons] of diluted sealer per square meter [square yard]. The second coat shall be diluted only to the extent necessary to obtain workability and applied at a rate of 1.1 to 2.2 L [0.25 to 0.50 gallons] of diluted sealer per square meter [square yard].

612.04 Method of Measurement. Bituminous sealing will be measured by the square meter [square yard] of surface sealed measured parallel to the surface.

612.05 Basis of Payment. The accepted quantities of bituminous sealing will be paid for at the contract unit price per square meter [square yard] complete in place.

Payment will be made under:

Pay Item	Pay Unit
612.06 Bituminous Sealing-Black	square meter [Square Yard]

SECTION 613 -- EROSION CONTROL BLANKETS

613.01 Description. This work shall consist of furnishing and installing erosion control blankets on previously prepared areas in accordance with the manufacturers instructions or as called for on the plans or otherwise authorized.

- (a) Temporary Erosion Control Blankets. Temporary erosion control blankets shall be installed on critical slopes, shoulder berms, esplanade strips, curb sections, in ditches and drainage ways and other previously prepared areas or as shown.
- (b) Extended Use Erosion Control Blankets. Extended use erosion control blankets shall be installed on slopes, sluiceways, stream bottoms and perennial shoreline edges and other previously prepared areas.

MATERIALS

613.02 Materials. Erosion control devices shall conform to the requirements specified in the following Subsections of Division 700 -- Materials.

Temporary Erosion Control Blankets	717.061
Extended-use Erosion Control Blankets	717.062
Ground Anchors	717.063

CONSTRUCTION REQUIREMENTS

613.03 Site Preparation. The area for erosion control blankets shall be prepared as follows:

- (a) Temporary Erosion Control Blankets. Soil must be loose or scarified, smoothly raked and free of stones, litter and any abrupt ground surface roughness under the blanket.
- (b) Extended Use Erosion Control Blanket. Soil shall be raked and free of stones, litter and any abrupt ground surface roughness under the blanket.

613.04 Seeding. All seed shall be sown prior to installing erosion control blankets. No loam will be required for Seeding, Method Number 2 and Method Number 3 unless called for on plans or designated. Loam will be required for Seeding, Method Number 1. No seeding or loam will be required in stream beds.

613.05 Installation of Temporary Erosion Control Blankets. The blankets shall be rolled out in the direction of water flow, from top to toe of high slopes and along berm contours. The uphill end of blanket shall be anchored in a trench no less than 150 mm [6 inches] deep and overlapped on the adjoining ends no less than 75 mm [3 inches]. Parallel strips shall be overlapped 100 mm [4 inches] on the sides. Approved anchor staples shall be placed as required by the manufacturer.

613.06 Installation of Extended-use Erosion Control Blankets. The blankets shall be rolled out in the direction of water flow from top to toe of high slopes and along shoreline contours. The uphill end of the blanket strips shall be anchored in a trench 300 mm [12 inches] deep and overlapped 150 mm [6 inches] on the ends. The strips shall overlap 150 mm [6 inches] on the sides. Approved anchor staples shall be placed as required by the manufacturer.

613.07 Vacant

613.08 Method of Measurement. Erosion control devices will be measured by the square meter [square yard] based on the width and length of the blanket measured on the ground.

613.09 Basis of Payment. Erosion control blankets of the type specified will be paid for at the contract unit price per square meter [square yard] complete in place and accepted. Such payment shall be full compensation for furnishing and installing the blankets and initial seeding under blanket in accordance with this specification and for all required maintenance.

Payment will be made under:

Pay Item	Pay Unit
613.319 Temporary Erosion Control Blanket	square meter [Square Yard]
613.329 Extended Use Erosion Control Blankets	square meter [Square Yard]

SECTION 614 -- VACANT

SECTION 615 -- LOAM

615.01 Description. This work shall consist of furnishing and placing loam topsoil for seeding or sodding, in reasonably close conformity with the thicknesses called for on the plans or as authorized.

MATERIALS

615.02 Materials. Loam shall be a good grade of topsoil from a site approved by the Engineer. The loam shall be loose and (friable) and shall be free from admixture of subsoil, refuse, large stones, clods or roots or other undesirable foreign matter. It shall be free of weeds, roots or

rhizomes of "Witch Grass" (*Agropyronrepens*) or other undesirable grasses. Muck, peat or other excessively acid soil containing excessive proportions of either clay or sand will not be accepted.

When designated on the plans or directed, existing topsoil, found within the lines of improvement in excavation areas, embankment areas or both, shall be salvaged by excavating and stockpiling by the Contractor for later use as loam on slopes and other areas or on future work. Stockpiles shall be placed at designated locations.

Additional loam to complete the project, if required, shall be obtained by the Contractor from sources beyond the right-of- way. Unless designated for future work, surplus salvaged topsoil not required for use on slopes shall be graded to match the surrounding terrain and the area seeded and mulched.

CONSTRUCTION REQUIREMENTS

615.03 Preparing Areas. All slopes and other areas where loam is to be placed shall be shaped to the required grade. Before placing the loam on hard or compacted soils, the areas under preparation shall be scarified and loosened to a depth of at least 50 mm [2 inches].

615.04 Placing Loam. Loam shall be spread uniformly on prepared areas to the depth shown on the plans or as directed. Any remaining clods, roots, stones over 50 mm [2 inches] in its greatest diameter and all other foreign matter, shall be removed. On areas to be seeded under Method Number 1 as specified in Subsection 618.09(a), all rocks over 25 mm [1 inch] in diameter shall be removed. All loam shall be brought to a true, even surface, meeting the required grade.

615.05 Method of Measurement. Loam will be measured by the cubic meter [cubic yard] complete in place after finishing to the required depths as shown on the plans or directed. Lateral measurements will be parallel with the slope of the ground.

Removal of existing topsoil salvaged from within the lines of improvement, as specified in Subsection 615.02, will be measured for payment in accordance with subsection 203.18. The depth of the salvaged topsoil to be included for payment shall be the depth authorized. There will be no deduction from borrow quantities resulting from the authorized excavation of salvaged topsoil.

615.06 Basis of Payment. The accepted quantities of loam will be paid for at the contract unit price per cubic meter [cubic yard] complete in place. Existing topsoil removed from within the lines of improvement and stockpiled for later use as loam will be paid for under Pay Item 203.20, Common Excavation, after removal and stockpiling, and will be paid for under Pay Item 615.07, Loam, when placed in its final position. Grading surplus topsoil, salvaged but not required for use on slopes as loam, will be paid for under the appropriate items of Section 631 -- Equipment Rental, Section 618 -- Seeding and Section 619 -- Mulch.

Payment will be made under:

Pay Item	Pay Unit
615.07 Loam	cubic meter [Cubic Yard]

SECTION 616 -- SODDING

616.01 Description. This work shall consist of furnishing and placing approved live sod on a bed of friable soil for the protection of culvert ends, sluiceways, mowed slopes, mowed drainage ways, pedestrian surfaces, esplanade strips and other areas called for on the plans or authorized.

MATERIALS

616.02 Materials. Materials shall meet the requirements in the following Subsections of Division 700 -- Materials:

Fertilizer	717.01(b)
Agricultural Ground Limestone	717.02

Sod may be either field sod or cultivated sod.

- (a) Field Sod. The sod shall consist of a dense, well rooted, vigorous growth of turf forming perennial grasses indigenous to the locality where it is to be used. Sod shall be taken from approved sources where the soil is of such character that the sod will not break or crumble during cutting, transporting and laying. Sod shall be reasonably free from noxious weeds, annual grasses, moss, large stones, tree roots or other materials harmful to growth or material that will interfere with future mowing or subsequent maintenance of the sodded areas. Field sod shall be cut to a uniform minimum thickness of approximately 50 mm [2 inches].
- (b) Cultivated Sod. The sod shall consist of turf obtained from an approved commercial sod farm and shall be substantially free from objectionable grassy and broad leaf weeds. Cultivated sod shall be cut to a uniform minimum thickness of approximately 25 mm [1 inch].

Pegs for holding sod shall be of approved sound wood and at least 19 mm [3/4 inch] in thickness and at least 200 mm [8 inches] long.

CONSTRUCTION REQUIREMENTS

616.03 Cutting and Transporting. The area from which sod is to be cut shall be mowed to a height of approximately 50 mm [2 inches] and cleared of excess grass clippings and other foreign matter shortly before sod cutting starts. The sod shall be freshly cut with an approved sod cutter in strips of uniform thickness having a minimum width of 300 mm [12 inches] and not less than 300 mm [12 inches] long and transported in an unbroken condition to the area to be sodded. Sod shall be placed in its final position promptly after cutting. No storage of sod will be allowed unless

specifically authorized. Cut sod shall be protected from drying from sun and wind during the time between cutting and placing.

616.04 Site Preparation. When sod is to be placed over loam, the areas to be sodded shall be brought to the grades shown on the plans, allowing for the thickness of the sod. Areas to be sodded shall be cleared of large stones, roots, clods and other debris that might interfere with laying sod or subsequent maintenance of the sodded area. Fertilizer and agricultural limestone shall be applied, either before or after laying sod, at the rate of not less than 15 kg per 100 m² [30 pounds per 1,000 square feet] for fertilizer and not less than 12 kg per 100 m² [25 pounds per 1,000 square feet] for agricultural limestone. On hard packed soil, the areas under preparation shall be scarified, harrowed or otherwise loosened to a depth of at least 50 mm [2 inches] before placing loam and laying sod, unless otherwise directed.

616.05 Laying Sod. Sod shall be moist when laid and shall be placed on a moist soil bed. The sod shall be placed at right angle to the flow of water, commencing at the lower end and tightly fitted, edge to edge, to provide a uniform surface. Transverse joints shall be staggered. Gaps shall be filled with sod plugs or loam to produce a tight surface.

The inlet edges of sod in waterways and other edges exposed to water scour, shall be turned down and buried to a depth of at least 75 mm [3 inches] with tamped earth. Where the sod is in danger of being displaced during sodding operations the workmen shall work from ladders or planks.

The sod shall be compacted and bonded to the soil with an approved tamper or light roller. After tamping or rolling the sod shall have a smooth, even surface free from humps and depressions.

Unless otherwise directed on slopes and on all drainage ways with a gradient of 2 horizontal to 1 vertical or steeper, the sod shall be anchored with wooden pegs. The pegs shall be spaced not over 600 mm [2 feet] apart in any direction and driven through the sod into the ground approximately perpendicular to the ground surface. The top of the pegs shall be driven flush with the surface of the sod.

The Contractor shall water the sod when necessary and shall insure continued growth of the grasses. Sod not surviving until the completion of the project shall be removed and replaced by the Contractor at his expense.

Frozen sod shall not be used nor shall sod be placed upon frozen soil.

616.06 Method of Measurement. Sodding will be measured by the square meter [square yard], measured along the slope, complete in place to the dimensions shown on the plans or as otherwise directed.

616.07 Basis of Payment. The accepted quantities of sodding will be paid for at the contract unit price per square meter [square yard] complete and accepted in place, which shall include supplying and applying fertilizer and agricultural limestone. Necessary excavation for placing sod will not be paid for separately but will be considered incidental to the contract unit price for sodding.

Payment will be made under:

Pay Item

Pay Unit

616.08 Sodding

square meter [Square Yard]

SECTION 617 -- SOIL CONDITIONERS

Reserved

SECTION 618 -- SEEDING

618.01 Description. This work shall consist of preparing the soil, furnishing and applying agricultural ground limestone, fertilizer and grass seed to areas shown on the plans or authorized.

- (a) Seeding, Method Number 1 shall consist of soil preparation and the application of "Park Mixture" to loamed areas which are expected to be maintained by frequent mowing.
- (b) Seeding, Method Number 2 shall consist of soil preparation and the application of "Roadside Mixture Number 2" to loamed or unloamed areas which are expected to be maintained by infrequent mowing.
- (c) Seeding, Method Number 3 shall consist of soil preparation and the application of "Roadside Mixture Number 3" to loamed or unloamed areas which are not expected to be mowed.
- (d) Temporary Seeding shall consist of the application of fertilizer and seed to slopes and other areas to control soil erosion during construction and prior to completion of permanent erosion control and other landscape requirements.
- (e) Crown Vetch seeding shall consist of the application of seed with inoculant, to slopes and other areas, by adding to a grass seed mix.
- (f) Reed Canary Grass seeding shall consist of the application of seed by adding to Seeding Method Number 2 or seeding separately as directed.
- (g) Annual Rye Grass seeding shall consist of the application of seed by adding to a grass seed mix.
- (h) White Clover seeding shall consist of the application of seed with inoculant by adding to a grass seed mix.

MATERIALS

618.02 Materials. Materials shall meet the requirements in the following Subsection of Division 700 -- Materials:

Fertilizer (applied for seed establishment)	717.01(a)
Fertilizer (applied for refertilization)	717.01(b)
Agricultural Ground Limestone	717.02
Seed	717.03

Seed for temporary seeding shall be oats, grain, rye or seed conforming to the requirements of Subsection 717.03(a).

CONSTRUCTION REQUIREMENTS

618.03 Rates of Application. Application rates are set forth below. One unit is defined as 100 m² [1,000 square feet].

- (a) Agricultural ground limestone shall be applied at the rate of 15 kg [30 pounds] per unit, all methods.
- (b) Fertilizer applied for seed establishment, shall be applied at the rate of 4 kg [8 pounds] of Packed Weight [Ton] Granular Fertilizer (18.5-18.5- 18.5) per unit, all methods.
- (c) Fertilizer applied for refertilization, shall be applied at the rate of 7 kg [15 pounds] of inert filler granular fertilizer (10-10-10) per unit.
- (d) The seed mixture for Method Number 1 and Method Number 2 shall be sown at the rate of 1.5 kg [3 pounds] per unit. For Temporary Seeding, rates greater than 1.5 kg [3 pounds] per unit shall be applied as directed.
- (e) The seed mixture for Method Number 3 shall be sown at the rate of 1 kg [2 pounds] per unit. Crown vetch seed shall be treated with inoculant immediately prior to sowing in accordance with the directions of the supplier. When the hydraulic method of seeding is used, 4 times the normal recommended rate of inoculant shall be used.
- (f) Reed Canary grass shall be applied by adding to a grass seed mix or by seeding separately on areas also seeded with the Seeding Method Number 2 or Seeding Method Number 3.

The seed shall be applied evenly and uniformly at the rate of 0.25 kg [1/2 pound] per unit of seeding. If seed is not applied by the use of a hydroseeder and the area not mulched, the seed must be raked lightly into the surface of the soil promptly after being applied.

- (g) Annual Rye grass, when called for, shall be added to a grass seed mix at the rate of 0.25 kg [1/2 pound] per unit.
- (h) White Clover, when called for, shall be added to a grass seed mix at the rate of 0.25 kg [1/2 pound] per unit.
- (i) Crown Vetch, when called for, shall be added to a grass seed mix at the rate of 0.25 kg [1/2 pound] per unit. Crown vetch seed shall be treated with inoculant immediately prior to sowing in accordance with the directions of the supplier. When the hydraulic method of seeding is used, four times the normal recommended rate of inoculant shall be used.

618.04 Time of Seeding. The recommended seeding time is from April 1st to September 15th. The Contractor will seed at other times as directed.

618.05 Fertilizing and Applying Agricultural Ground Limestone - Conventional Method - Before Seeding. Fertilizing and applying agricultural ground limestone shall be done when the soil is moist and at least 24 hours before sowing the seed. The fertilizer and lime shall be applied to the soil by a mechanical spreader or other approved method capable of maintaining a uniform rate of application and shall be thoroughly harrowed, raked or otherwise mixed with the soil to a depth of not less than 25 mm [1 inch]. The fertilizer and agricultural limestone shall not be applied together unless applied hydraulically. Fertilizer shall not be applied on frozen ground unless authorized.

618.06 Sowing Seed - Conventional Method. Seed of the required mixture and quality shall be sown by a mechanical seeder or other method which will sow the seed uniformly at the required rate. Unless seeding is to be mulched the same day, seeded areas shall be lightly raked by hand to mix the seed with the topsoil. Lawn areas shall be rolled with a light lawn roller.

618.07 Sowing Seed and Distributing Fertilizer With Seed - Hydraulic Spray Method. The hydraulic spray method of sowing seed may be used where approved. This work shall be done with an approved machine. Seed and fertilizing materials shall be mixed with water in the tank of the machine and kept thoroughly agitated so the materials are uniformly mixed and suspended in the water at all times during operation. The spraying equipment must be designed and operated to distribute seed and fertilizing material evenly and uniformly on the designated areas at the required rate. Seeds must be lightly raked into the surface of the soil unless seeding is to be followed by mulching the same day.

618.08 Mulching. Where called for, mulch shall be applied as specified in section 619 -- Mulch.

Mulch will normally be applied directly after sowing the seed, but where hydraulic seeding is used, the Engineer may direct that mulch be applied upon completion of the grading, with hydraulic seeding to follow.

618.09 Construction Method.

(a) Seeding Method Number 1.

1. Preparing the Soil. After the areas to be seeded have been brought to grade and loamed, the top 50 mm [2 inches] of soil shall be harrowed or otherwise loosened. On freshly graded areas the Engineer may allow the harrowing to be omitted if in his judgment, the surface soil is loose enough to provide a bedding for the seed. The Engineer may require hand raking unless a satisfactory surface is produced by other means.
2. Fertilizing and Applying Agricultural Ground Limestone. Fertilizer and agricultural ground limestone shall be applied to the prepared area as called for under Subsection 618.05 or 618.07.
3. Sowing Seed. The seed shall be sown on the prepared areas as called for under Subsection 618.06 or 618.07. Unless mulch is to be used, seed, fertilizer and agricultural ground limestone shall be applied as called for under Subsection 618.05 and 618.06 unless otherwise directed.
4. Mulching. Where directed, mulch shall be applied as specified under Subsection 618.08.

(b) Seeding Method Number 2 and 3.

1. Preparing the Soil. After the loamed or unloamed areas to be seeded have been brought to grade, all ground not loose and friable shall be scarified to a depth of at least 50 mm [2 inches] immediately before seeding or mulching. All stones over 100 mm [4 inches] in the greatest measurement in the unloamed areas and all objects which would be detrimental to mowing, shall be removed and disposed of as directed. Hand raking will not be required provided an acceptable surface can be obtained by other means.
2. Fertilizing and Applying Agricultural Ground Limestone. Fertilizer and agricultural ground limestone shall be applied to the prepared areas as specified in Subsections 618.05 or 618.07 unless otherwise called for on the plans or directed.
3. Sowing Seed. The seed shall be sown as specified under Subsections 618.06 or 618.07 unless otherwise called for on the plans or directed.
4. Mulching. Mulch shall be applied as specified under Subsection 618.08 unless otherwise called for on the plans or directed.

618.10 Maintenance and Acceptance.

Areas fertilized and seeded by the conventional method will be accepted only upon attainment of a reasonably thick uniform stand of grass free from sizeable thin or bare spots.

Areas fertilized and seeded by the hydraulic method and mulched as specified in Subsection 618.08, will be accepted at the time they are seeded and mulched. Any additional work on the seeded or mulched areas, as directed, thereafter will be paid for under the appropriate contract bid item or by force account extra work.

The Contractor shall maintain each seeded area until acceptance of the individual area. Maintenance shall consist of providing protection by erecting necessary signs or barriers.

The Contractor will be relieved of further responsibility for maintaining the area or repairing damage other than that resulting from his own operations or that of a subcontractor's operation. Refertilizing and reseeding may be required as directed. Payment will be made under the appropriate items. Areas refertilized, reseeded and remulched by either method will be subject to the acceptance procedures described above.

When all other work on the project has been completed and some of the seeded areas still have not attained a satisfactory growth of grass, the area shall be reseeded, refertilized and remulched as directed. The Contractor will be relieved of further expense for maintaining the areas, except for damage resulting from his own operations or that of a subcontractor's operation.

618.101 Applied Water. Applied water shall be used to aid in establishing seed on critical areas when maintenance and protection by the Contractor is not required by these specifications. Water from approved sources shall be uniformly sprayed on designated areas that have been seeded. Water shall be applied in a manner to avoid washing out seed or soil.

618.102 Refertilization. Fertilizer for refertilization shall be applied to existing grassed areas, as shown on the plans or as directed by the Engineer, between the periods of April 15th to June 30th and August 15th to October 30th, except that fertilizer shall not be applied on frozen ground. The fertilizer shall be thoroughly mixed with water and the mixture sprayed uniformly over the area to be fertilized. Water shall be applied at the rate of 120 L [30 gallons] per unit, regardless of the grade of fertilizer used.

Spray must not be so coarse, applied so directly or applied so forcibly as to uproot or damage grass plants.

618.11 Method of Measurement. Seeding will be measured for payment by the area of seeded surface in units of 100 m² [1,000 square feet].

Measurements will be made along the slope of the ground or, at the discretion of the Engineer, the quantity may be determined from the number of units loaded into the hydroseeder and applied at the rates specified in Subsection 618.03.

When included as separate contract items, temporary Seeding, Crown Vetch Seed, Reed Canary Grass Seed, White Clover Seed and Annual Rye Grass Seed will be measured for payment by the number of kilograms [pounds] of seed satisfactorily applied, computed from delivery slips as specified in Subsection 109.01(f) except that a certified weighmaster and check weighing will not be required.

Applied water will be measured for payment by the cubic meter [unit of 1,000 gallons (MG)] in calibrated tanks or distributors or by accurate water meters. Delivery slips, as specified in Subsection 109.01(f), will be required.

Refertilization will be measured for payment by the number of kilograms [pounds] of dry fertilizer satisfactorily applied. Delivery slips, as specified in Subsection 109.01(f),

will be required, except that weight will be determined from the weight stated on each bag and the number of bags used. Weighing by a weighmaster will not be required.

618.12 Basis of Payment. The accepted quantities of seeding or reseeding will be paid for at the contract price per unit for the method specified which shall include furnishing and spreading lime, fertilizer and seed.

The accepted quantity of Crown Vetch, Reed Canary Grass, White Clover and Annual Rye Seed will be paid for at the contract unit price per kilogram [pound] which shall include inoculant when required.

The accepted quantity of Temporary Seeding will be paid for at the contract unit price per kilogram [pound] which shall include furnishing fertilizer and lime, the type of seed designated and for applying the seed at the designated rates of application and if necessary, raking the ground surface.

The accepted quantity of Refertilization will be paid for at the contract unit price per kilogram [pound] satisfactorily applied to designated areas at the rate specified. Areas refertilized at the direction of the Engineer, will be included for payment.

When fertilizer is omitted from the seeding items at the direction of the Engineer, such seeding will be paid for at 85% of the contract price for the appropriate item.

Applied water will be paid for at the contract unit price per cubic meter [MG].

Upon completion of seeding the amount due for these items will be payable.

Loam and mulch will be measured and paid for as provided in Section 615 -- Loam and Section 619 -- Mulch.

Payment will be made under:

Pay Item	Pay Unit
618.13 Seeding Method Number 1	Unit
618.14 Seeding Method Number 2	Unit

618.141	Seeding Method Number 3	Unit
618.15	Temporary Seeding	kilogram [Pound]
618.16	Crown Vetch Seed	kilogram [Pound]
618.17	Reed Canary Grass Seed	kilogram [Pound]
618.18	White Clover	kilogram [Pound]
618.19	Refertilization	kilogram [Pound]
618.20	Annual Rye Grass Seed	kilogram [Pound]
618.25	Applied Water	cubic meter [MG]

SECTION 619 -- MULCH

619.01 Description. This work shall consist of furnishing and applying hay, straw or cellulose fiber for covering slopes and other areas with a mulch as shown on the plans or authorized.

MATERIALS

619.02 Mulch. Material shall conform to the requirements specified in the following subsections of Division 700 -- Materials:

Mulch	717.04
Mulch Binder	717.05

CONSTRUCTION REQUIREMENTS

619.03 General. In areas where mulch is primarily used to prevent erosion, hay or straw mulch shall be applied. Cellulose fiber mulch shall not be applied in those areas.

Cellulose fiber mulch shall only be used on areas approved, which may include, but are not limited to, lawns adjacent to developed property, areas subject to high air blasts created by moving vehicles, areas where hay mulch would create a hazard and on projects where small amounts of mulch are required.

619.04 Applying Mulch. Mulch shall be any of the following types of material.

- (a) Hay or straw mulch for both seeded and unseeded areas shall be spread evenly and uniformly over the designated areas. Unless otherwise directed, mulch shall be applied at the rate of 3.5 to 4.5 Mg/ha [1.5 to 2 tons per acre]. Too heavy an application of mulch shall be avoided. Lumps and thick mulch material shall be thinned.

Unless otherwise authorized, the mulch shall be anchored in place by uniformly applying an acceptable mulch binder. Mulch binder shall be applied as soon as the

mulch is placed. Application of a concentrated stream of mulch binder will not be allowed. Approved mulch binder will be asphalts or cellulose fiber. Water spray may be used as a temporary binder.

Temporary mulching shall be spread immediately to protect wetlands and surface waters from erosion during all stages of construction throughout all seasons of the year. Temporary mulching shall be used promptly to protect wetlands and surface waters from soil runoff during stage of final construction phases throughout all seasons of the year. Salvaged wood chips may be used as temporary mulch when authorized by the Engineer.

- (b) Cellulose Fiber Mulch shall be applied as a waterborne slurry. The cellulose fiber and water shall be thoroughly mixed and sprayed on the area to be covered so as to form a uniform mat of mulch at the rate of not less than 20 kg [40 pounds] of mulch material per 100 m² [1000 square feet] unit of area.

Cellulose fiber mulch may be mixed with the proper quantities of seed, fertilizer and agricultural limestone as required under Section 618 -- Seeding or may be applied separately the next day after seeding.

- (c) Bark mulch shall be placed to cover the slope with a 75 mm [3 inch] deep blanket.

619.05 Maintenance. The Contractor shall maintain the mulch by repairing all damaged mulch and by correcting all shifting of the mulch due to wind, water or other causes, until an acceptable growth of grass has been achieved. Additional mulch shall be furnished as necessary and will be paid under pay item 619.12.

If cellulose fiber mulch is used, any reseeding will require additional cellulose fiber mulch.

Bark mulch blanket will be accepted upon completion. Upon acceptance of each area, the Contractor will be relieved of further responsibility for maintaining that area or repairing damage except that resulting from his own or subcontractor's operations.

If water spray is used as a temporary binder, it shall be maintained in a manner acceptable to the Engineer.

619.06 Method of Measurement. Mulch will be measured by the area of mulched surface in units of 100 m² [1000 square feet].

Measurements will be made along the slope of the ground or, at the discretion of the Engineer, the quantity of mulch used for spot repairs, temporary erosion control and on other areas difficult to measure on the ground, may be determined from the number of 18 kg [40 pound] bales applied at the rate specified in Subsection 619.04.

619.07 Basis of Payment. The accepted areas mulched will be paid for at the contract price per unit, which shall be full compensation for furnishing and spreading the hay, straw or cellulose fiber mulch, the mulch binder for hay and straw mulch, and water spray used as temporary binder.

When mulch is measured by bales, each bale will be paid for at 60 percent of the contract price per unit for Pay Item 619.12.

Temporary mulching will be paid for at the contract unit price for Pay Item 619.12.

Payment will be made under:

Pay Item		Pay Unit
619.12	Mulch	Unit
619.13	Bark Mulch	Unit

SECTION 620 -- GEOTEXTILES

620.01 Description. This work shall consist of the furnishing and installing of woven geotextile fabric or nonwoven geotechnical fabric, hereinafter called fabric, as shown on the plans and Standard Detail, or as otherwise directed.

MATERIALS

620.02 Materials. Geotextiles shall meet the requirements in the following Subsections of Division 700 -- Materials:

Stabilization Geotextile	722.01
Drainage Geotextile	722.02
Erosion Control Geotextile	722.03
Reinforcement Geotextile	722.04

CONSTRUCTION REQUIREMENTS

620.03 Placement. Prior to placement of the fabric, the site shall be prepared to provide a smooth surface, except as otherwise required, which is free from obstructions and depressions which could result in the fabric being torn or punctured during the cover operation. The fabric shall be unrolled loosely and positioned as smoothly as possible on the surface to minimize wrinkles and folds.

When the fabric is to be placed in the roadway, the cover material shall be dumped on previously placed cover material or at the edges of the fabric and then pushed onto the fabric. The first layer of cover material shall be greater than 200 mm [8 inches] and first compacted by a track bulldozer. At no time shall construction equipment be allowed on the fabric when the fabric is covered with less than 200 mm [8 inches] of compacted cover material. Ruts shall be filled with additional cover material to maintain the minimum 200 mm [8 inches] cover over the fabric.

When the fabric is to be placed as a reinforcement geotextile, care shall be taken to tension the fabric prior to completely covering with aggregate.

When the fabric is to be placed in a ditch, shallow channel or downspout, the fabric shall be placed with the long direction parallel to the direction of water flow. All adjacent lengths of fabric shall be placed so that the upstream roll edge overlaps the downstream roll edge.

When sloped riprap is to be placed on fabric, the site shall be prepared to provide an undulating and uneven surface, as much as is practical. The fabric shall be placed loosely to prevent any bridging of the uneven surface.

Fabric to be placed on slopes shall have the long direction oriented up and down the slope as shown on the Standard Detail. All joints between adjacent fabric roll ends that may occur on the slope shall be overlapped shingle style.

When riprap or stone ditch protection is placed on fabric, the stones shall be placed so that they do not puncture or otherwise damage the fabric.

Except as hereinafter provided, fabric to be placed under riprap, where the stones weigh less than 110 kg [250 pounds], shall be Class A Erosion Control Geotextile.

Fabric to be placed under heavy riprap, or where the stone weights in plain riprap are greater than 110 kg [250 pounds], shall be nonwoven Class A Erosion Control Geotextile with a 150 mm [6 inch] thick protective aggregate cushion placed on top of the fabric to protect the fabric from damage. The aggregate cushion may be omitted if it can be demonstrated to the Engineer that no damage will occur to the fabric by the placement of the stone.

Fabric to be placed under stone ditch protection may be Class A Erosion Control Geotextile.

The height of drop of riprap stones less than 100 kg [250 pounds] shall be no greater than 1 m [3 feet] when a 150 mm [6 inch] thick protective aggregate cushion is utilized nor any greater than 300 mm [1 foot] if stones are placed directly on the fabric. The 150 mm [6 inch] thick protective aggregate cushion shall be in addition to the specified riprap thickness and shall meet the requirements for granular borrow for underwater backfill.

Riprap stones greater than 100 kg [250 pounds] shall not be placed by free-fall unless field trials are performed to the satisfaction of the Engineer, to determine the maximum height of drop that will not damage the fabric. In no case shall the maximum drop be greater than 1 m [3 feet].

At no time shall riprap stones be rolled down the slope where fabric has been placed.

620.04 Overlap and Seams. Adjacent lengths of fabric shall be joined by overlapping a minimum of 450 mm [18 inches] at the ends and sides except when sewing is specified or fabric is placed on slopes. All overlaps on slopes shall be placed as follows:

- (a) For slopes steeper than 1 vertical to 3 horizontal: Sewn seams or minimum 1 m [3 foot] overlaps with no pinning or staking allowed.
- (b) For slopes flatter than 1 vertical to 3 horizontal: Sewn seams or minimum 450 mm [18 inches] overlaps and pins or stakes may be used to anchor the overlaps at the recommended spacings.

When fabric is placed in the roadway, the fabric roll widths shall be chosen so that there will be a minimum number of overlaps of parallel rolls. The total width of surface covered is shown on the Standard Detail.

When sewn seams are to be used, field or factory seaming by machine will be allowed. All seams shall be sewn with polypropylene, polyester, or Kevlar thread which is a contrasting color to the fabric material. The "J-seam" shall be used with doublelocked stitches (Class 401), except the "flat" seam may be used for repair of damaged in-place fabric. The length of a stitch shall be between 3.5 and 8 mm. [Seams shall contain between 3 and 7 stitches per inch]. All field seams shall be double stitched with two parallel passes and the 2 rows of stitching shall be approximately 13 mm [1/2 inch] apart and shall not cross at any point. All stitching shall be at least 25 mm [1 inch] from the fabric edge. All seams shall be exposed with the seam up so that repairs can easily be made if faulty seams are encountered during inspection, as shown on the Standard Detail.

620.05 Protection of Fabric. To prevent damaging the fabric, the Contractor shall exercise necessary care while transporting, storing and installing the fabric.

Prior to installation, the fabric shall be protected from rain, from sunlight or other ultraviolet exposure and from dust, mud, debris or other elements that may affect its performance. Fabric which is torn, punctured or otherwise damaged shall not be placed. During installation, fabric shall not be left exposed for more than five days without being covered.

Fabric which is damaged after placement shall be replaced or repaired by placing a piece of the same type of fabric over the damaged area with at least an 450 mm [18 inch] overlap in all directions. When sewn seams are used, the Engineer may require damaged fabric be stitched together or the damage repaired by sewing a patch of the fabric over the damaged areas.

620.06 Sampling and Acceptance. A 220 by 280 mm [8½ by 11 inch] sample of each type of geotextile shall be taken from a representative roll and furnished along with the most recent manufacturer's product data sheet to the Engineer for his approval of the fabric before installation. The product data sheet shall include the test methods and the geotextile properties specified in Subsections 722.01, 722.02, 722.03 and/or 722.04. If the geotextile property values expressed in "minimum values" or "minimum average roll values" for any lot are less than the minimum permissible values in the specification, then the entire lot shall be rejected. These "minimum averages roll values" imply that the average test results from any roll within a lot or shipment meet or exceed the minimum permissible values required in the specification.

If the "minimum values" or the "minimum average roll values" are not available from the manufacturer, then the "average values" or "typical property values" for the mechanical properties only shall be reduced by 20 percent and then compared to the minimum permissible values in the specifications for determination of acceptance.

620.07 Method of Measurement. The quantity of geotextiles will be measured by the number of square meters [square yards] of surface area covered and in direct contact with the cover material. Measurement will not be made for overlaps, patches and repairs of damaged geotextile unless additional overlap width is required by the Engineer in which case measurement will be made for that added overlap area.

620.08 Basis of Payment. Geotextiles will be paid for at the contract unit price per square meter [square yard]. Such payment shall be full compensation for furnishing and placing geotextile fabric; for all required surface preparation; for all labor, tools, materials and equipment; for repairing torn and damaged geotextile; and when required, for sewing seams and for furnishing and placing all pins or stakes or other hold down devices; for excavation for and furnishing and placing protective aggregate cushion; and for all other incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
620.54 Stabilization Geotextile	square meter [Square Yard]
620.55 Stabilization Geotextile (sewn seams)	square meter [Square Yard]
620.56 Drainage Geotextile	square meter [Square Yard]
620.57 Drainage Geotextile (sewn seams)	square meter [Square Yard]
620.58 Erosion Control Geotextile	square meter [Square Yard]
620.59 Erosion Control Geotextile (sewn seams)	square meter [Square Yard]
620.60 Reinforcement Geotextile	square meter [Square Yard]
620.61 Reinforcement Geotextile (sewn seams)	square meter [Square Yard]

SECTION 621 -- LANDSCAPING

621.0001 Description. This work shall consist of furnishing and planting trees, shrubs, vines and other plants and shall include all planting operations and material as well as the care and replacement of the plants during the establishment period, all in accordance with the specifications, planting plans and schedules and the directions of the Engineer. Planting operations will be divided into three classes.

- (a) Class A Planting requires particular care in planting with extra loam usually furnished and excess excavated material disposed of.
- (b) Class B Planting will usually be done with whatever backfill soil is available at the plant site.
- (c) Class C Planting consists of deciduous shrubs or evergreen seedlings set in the existing soil.

Unless otherwise specified, planting shall be Class A.

MATERIALS

621.0002 General. All non-planting material shall conform to the requirements specified in the following Subsections of Division 700 -- Materials.

Tree Wound Paint	708.04
Fertilizer	717.01
Agricultural Ground Limestone	717.02
Mulch	717.04
Manure	717.08
Peat Humus	717.09
Plant Supporting Material	717.11
Wrapping Material	717.12

Loam shall meet the requirements specified in Subsection 615.02.

Water shall be free from oil, acids, alkalines, salts or any other substances harmful to plantings.

621.0003 Plant Material-All Classes.

- (a) All plants shall be first class representatives of their normal species or varieties, unless otherwise specified. All plants must have a good, healthy, well-formed upper growth and a large, fibrous, compact root system. Plants sheared into stiff or formal shapes will be rejected unless they have outgrown such shearing.

Large-growing, deciduous trees shall have straight trunks and a single leader or as may be characteristic of the species. Tops shall be thickly branched, densely foliated, well balanced and in good proportion to the height of the tree. Trees with weak trunks, thinly or irregularly branched or with unnatural shape of proportions due to undesirable pruning or for any other cause will be rejected. Trees with leaders or branches too severely cut back or with bottom limbs trimmed too high will be rejected or reduced to an applicable pay item.

Small-growing deciduous trees shall be thickly branched with a well-balanced, natural shape. Plants which are poorly furnished or have grown or been pruned into unnatural shapes will be rejected.

Tree "Clumps" shall have three or more main stems starting from the ground.

"Bush-form" trees shall be those with branches which start from the main trunk close to the ground.

- (b) All conifers and broad leaved evergreens, except Class C stock, shall be balled and burlapped and any other plants shall be balled and burlapped when called for on the plans or in the specifications. The depth of the ball shall be sufficient to encompass the fibrous and feeding root system necessary for the full recovery of the plant.
- (c) All plants shall have been grown under climatic conditions similar to those in the locality of the site of the project under construction or have been acclimated to such conditions for at least two years. All plants must have been grown in a latitude north of Washington, D.C. The Engineer may require a sworn affidavit stating the source where all plants were grown. Payment for plants may be withheld until this affidavit is received.

All plants shall be nursery grown unless otherwise stipulated. No plant will be considered nursery grown unless it has been transplanted at least once and has been growing in a nursery for at least 2 years. Where collected stock is allowed, all plants in addition to meeting all other requirements for nursery-grown stock, shall have a diameter of ball or root spread at least one-third greater than that required for nursery stock. Plants showing signs of lack of root pruning, cultivation or other proper nursery care will be classified as collected stock regardless of their source.

- (d) All plants shall conform to the current edition of the "USA Standard for Nursery Stock" sponsored by the American Association of Nurserymen (AAN), unless otherwise indicated in the plans or specifications.
- (e) All plants must be healthy and vigorous; free from disease, injurious insects and their eggs or larva, mechanical wounds, broken branches, decay or any other defects. All dealers in nursery stock operating in Maine must obtain a license from the State Horticulturist, State House, Augusta, Maine. It is suggested that the Contractor contact the Plant Pest Control Division, USDA, State House, Augusta, for information about required plant inspections.
- (f) All plants shall be true to name. Each bundle or each plant which when not tied in bundles, shall be legibly and securely labelled. The current edition of "Standardized Plant Names" prepared by the Editorial Committee of the American Joint Committee on Horticultural Nomenclature shall be the authority for all plant names.

Care shall be taken throughout the operation to keep each plant species or variety segregated and labelled. The Engineer will reject any plants concerning any doubt or confusion arising as to nomenclature, either at the time of delivery or at any subsequent time.

- (g) All precautions that are customary in good trade practice shall be taken to insure upon arrival at the planting site the plants are in good condition for successful growth. All plants must show appearance of normal health and vigor. Plants with loose or broken balls; dried out roots, twigs or needles; or plants which have become overheated in transit or are found not to comply with these specifications in any way will be rejected. The Engineer will not assume responsibility for such rejected material.

The Engineer reserves the right to plainly mark all rejected plants with paint or by other means to ensure that they are not used on the job. Rejected plants may not be used on the project, will not be paid for and must be replaced with approved plants. If plants with communicable diseases are not removed or destroyed immediately, upon discovery of the disease, all plants that were left in contact will also be rejected.

621.0004 Plant Size and Root Balls.

- (a) Class A and Class B Plants. The plant sizes specified in the "USA Standard for Nursery Stock" are the minimum sizes acceptable. Plants which meet the sizes specified but do not have a normal shape and balance between height and spread will be rejected. Thin, poorly branched or sparsely rooted plants will be rejected, regardless of whether they meet the minimum technical requirements of the USA Standard.

Where bare roots are irregular, the size of the root spread will be the average root spread considering all sides of the plant and not the maximum root spread. The Engineer may allow moderate deviations from exact sizes of plants which normally have irregular root systems.

Coarse-rooted plants which lack sufficient fibrous feeding roots will be rejected.

Recently cut stubs of large roots on either balled or bare root stock will be considered evidence of lack of proper nursery care and root-pruning and will be sufficient grounds for rejecting such plants or classifying them as collected stock requiring a diameter of ball or root spread, one-third greater than for nursery stock. Acceptable roots will retain sufficient fibrous feeding roots.

Where a size range with a maximum and minimum is given, an average size is required. At least 40 percent of the plants in a size range shall be at or above the average for this size range. Basis for payment for all undersized plants will be reduced to an applicable pay item, unless conditionally directed by the Engineer. This will apply to delivered plants, excessively pruned plants and replacement plants.

A solid ball is referred to as one encompassing the roots of a plant. A solid ball shall consist of the soil in which the plant was originally grown. The ball shall have been dug up in such a manner as not to disturb the roots. Where such a ball is required the designation B and B, Balled and Burlapped, will be used. No B and B stock will be accepted if this solid soil ball has disintegrated or if loose soil apparently has been packed around the roots.

Peat Balls and other fiber material will not be acceptable where B and B stock is called for, but said root balls may be furnished where bare root stock is called for if approved by the Engineer.

Caliper of trees shall be the diameter of the trunk taken 150 mm [6 inches] above the root collar.

- (b) Class C Plants. Unless otherwise specified, plants used in Class C planting shall be seedlings or lining out stock with heavy, fibrous, compact root systems. The comparative size of the plants shall be as stated under the heading "Seedling Trees and Shrubs" in the "USA Standard for Nursery Stock". All conifers must have dormant buds and secondary needles. Where B and B plants are designated, ball sizes shall be the same as Class A and B plants. There will be no waiver of oversized stock herein.

621.0005 Plants Purchased from the Department. The Contractor will be required to purchase certain plants, when listed on the plans, from the Department. The Contractor will be charged for the plants at prices listed by the Department and this cost should be included as part of the bid item. If any plants are required as replacements for plants which failed to survive on the job, additional charges will be made at the same prices. These plants are grown in the State Forest Nursery, Greenbush, Maine.

Quantities of plants will be listed as coming from the State Forest Nursery based on inventories prior to the letting of the Contract. Unexpected losses may occur due to various natural causes, prior to planting time. In the event that shortages occur in certain sizes and varieties and acceptable substitutes are not available in the nursery, the Contractor shall furnish such plants at the same contract price for plant and planting.

Procedures in handling these plants shall be as follows:

- (a) The Contractor shall dig the plants at the nursery, after first assuring himself that the plants are alive and in good condition. Digging and handling shall be the same as for all other plants of the same class. The Contractor will furnish burlap or other necessary materials for wrapping plant balls and will transport the plants to the job site.
- (b) Every effort shall be made to move these plants while they are still dormant and before the leaf buds open. The Engineer may require that any deciduous plants moved after the leaves start to develop shall be balled and burlapped or potted at the Contractor's expense.

- (c) The State Forest Nursery is under the control of the State Forest Service. The Contractor shall carefully conform to any rules and regulations, in regard to the use of the nursery, which have been promulgated.
- (d) The Contractor shall notify the Engineer at least 24 hours in advance of digging plants in the nursery. He shall at no time enter the nursery or dig plants except under the supervision of a job inspector or nursery personnel authorized by the Engineer and by the Forest Service to perform this function. Upon arriving at the nursery, he shall report to the nursery superintendent or his representative before starting any digging operation.
- (e) The Contractor shall dig only those plants designated for removal by the Engineer. He shall use great care not to damage plants in the nursery or to unnecessarily clutter or damage the nursery grounds. His operation shall be kept clean and neat at all times. Earth excavated when digging plants shall be replaced in the holes, but fine grading will not be required. The Contractor will be held liable for all damage to plants or nursery property.
- (f) Plants from the State Forest Nursery shall be planted on the project as soon as feasible after digging. Authorization to dig plants will not be given until preparations have been made for prompt planting, unless the Engineer directs otherwise.
- (g) The Contractor's liability under each bid item for plants purchased from the Department of Transportation shall be the same as for all other plant bid items.

621.0006 Inspection. On request, any nursery stock within the State of Maine will be inspected prior to delivery to the job site. Unless plants are inspected in the nursery, the Contractor may be required to submit samples of each size and variety of plant for approval prior to the delivery of large numbers of plants to the job site. A preliminary check of the plants will be made at the time of delivery for condition of the plants and conformity to the specifications. Another inspection of individual plants will be made just prior to planting. No plants shall be planted which have not been inspected. In order to facilitate this inspection, the Contractor shall inform the Engineer at least 24 hours in advance as to what plants are to be planted and in what location. Any plants which are planted without receiving this inspection may be rejected and must be removed and replaced with inspected stock. Due to the difficulty of identifying dormant plants and to the detrimental effect that excessive handling can have on the health and vigor of plants, conditional approval only will be given to plants in preliminary and intermediate inspections. Inspection will continue throughout the life of the contract up to the time of Final Acceptance. Plants which are not true to name, do not conform to the specifications, show evidence of improper handling or lack of proper care or which appear to be in a seriously unhealthy condition must be removed by the Contractor at once and replaced by acceptable plants as soon as the planting season allows. Dead or unhealthy plants will not be allowed to remain on the job site. Any such plants when pointed out to the Contractor by the Engineer shall be removed at once. If this occurs during the planting season, these plants shall be replaced at once; if between planting seasons, they shall be replaced at the next subsequent planting season, unless conditionally directed by the Engineer for evergreens and other preferred spring planted items. Unsatisfactory work will not be paid for during the establishment period.

CONSTRUCTION REQUIREMENTS

621.0017 General. Planting operations shall be performed in accordance with the plans and specifications and as directed by the Engineer. Although the work will fall under the jurisdiction of the Engineer, the Contractor shall, nevertheless, be responsible for the performance and completion of the work and shall retain a competent foreman at the site at all times when work is in progress. In addition he shall provide a sufficient number of experienced and capable men to carry out the work efficiently. Specifically, in addition to the foreman, the Contractor must have on the job a sufficient number of men capable and experienced in locating and spacing plants in beds, in plant identification, in handling and planting shrubs and trees, in pruning, in staking and any other skills required to carry out the work efficiently and correctly. Not less than two such men shall be employed on the project at all times when staking or any other work is in progress, except when as the Engineer certifies that their services are not needed. They shall be classified as "Landscape Workers".

621.0018 Layout. The location of plants as shown on the plans shall be considered approximate only. The exact locations will be designated on the ground by the Engineer, making such changes as may be required to adjust the planting to local conditions. Plant quantities may, in some cases, be increased or decreased as provided in Section 104.02. Locations for trees and outlines of areas to be planted to shrubs shall be staked out on the ground by the Contractor as directed by the Engineer at least 48 hours before herbicides are applied and any plant pits or beds are dug. Equipment, labor and approved labelled stakes for this purpose are to be furnished by the Contractor.

The Contractor shall furnish at least two types of stakes for use in marking plant locations. All shall be of planed lumber and shall be sharpened on one end. Layout stake samples shall be approved by the Engineer prior to Contractor commencing any work on the project.

Type A stakes shall be 900 to 1200 mm [3 to 4 feet] long and shall be of reasonably strong, sound 25 x 50 mm [1 x 2 inches], 25 x 75 mm [1 x 3 inches] or 38 x 38 mm [1½ x 1½ inches] stock. These stakes will be used mainly for marking the location of individual trees.

Type B stakes shall be 450 to 600 mm [1½ to 2 feet] long. Other dimensions will be the same as for Type A stakes.

The Contractor will be required to mark the stakes legibly with indelible marking material and will be required to supply at least six colors of paint to be used in segregating different groups of stakes. He will also be required to furnish personnel, capable of locating plants from plans, to carry out the staking under the direction of the Engineer.

Before actively starting work on the project, the Contractor shall provide the Engineer with a planting sequence schedule to be used in establishing priorities in staking plant locations. The Contractor shall give the Engineer at least four days advance notice of any deviations from this schedule. The Engineer will not be responsible for any delay or inconvenience caused by unfinished staking resulting from the Contractors failure to follow the above procedure.

All stakes used to locate plants shall be replaced in the correct plant pits after each operation and shall remain there until the Engineer directs their removal. When plants are set out in wrong locations due to stakes being misplaced during digging and planting operations, the Contractor shall be required to move the misplaced plants to the proper location at his own risk and expense.

The Contractor will also be required to adequately mark the outline of areas planted to evergreen seedlings or similar low plants, to protect the areas from accidental mowing by State maintenance crews. Type A stakes, painted over their entire length, will be used for this purpose. The Contractor will install these stakes around the perimeter of each area immediately after the area is planted and shall maintain these stakes for the duration of the contract. Although some variation will occur in the spacing of these stakes, the minimum distance between stakes will be 15 m [fifty (50) feet].

621.0019 Plant Pits and Beds.

- (a) Plant Designation. Plant beds outlined on the plans with solid lines and hatched must have the entire surface cultivated, cleared of weeds and be completely covered with mulch. Actual mulch limit will extend 750 mm [2½ feet] out from the center of plant or to the pavement edge, bridge wall and roadside face of guardrail. Cultivation must include complete removal of all weed and grass roots, loose stones over 75 mm [3 inches] maximum diameter and any other debris. Approved herbicides are permitted for weed control in place of sod removal.

Plant locations outlined by broken lines indicate that the plants will be handled individually and the area of the plant pit only will be cultivated and mulched.

Hatched areas not outlined indicate random planting, usually of seedling stock, for reforestation or erosion control.

- (b) Rock Excavation. When ledge or boulders over 0.25 m³ [¼ cubic yard] in size are encountered in digging plant pits, the Contractor shall notify the Engineer who will change the location of the plants. No excavation of ledge or boulders over 0.25 m³ [¼ cubic yard] in volume will be required and no extra payment will be made for rock excavation or for shifting of plant holes due to rock.

- (c) Class A Planting. Size of plant pits shall bear the following relationship to the spread of roots or rootball diameter of the plants to be planted in them:

For root spreads or ball diameters up to 600 mm [2 feet], pit diameters shall be 1½ times the root spread. For root spreads or ball diameters over 600 mm [2 feet] and less than and including 1200 mm [4 feet], pit diameters shall be 600 mm [2 feet] greater. For root spreads or ball diameters over 1200 mm [4 feet], the pit diameter shall be 900 mm [three feet] greater.

The minimum depth of plant pits shall be as follows:

For vines and for shrubs up to 600 mm [24 inches] in height, the depth shall be not less than 375 mm [15 inches].

For shrubs and trees from 600 mm [24 inches] to 2500 mm [8 feet] in height, the depth shall be not less than 450 mm [18 inches]. For trees above 2500 mm [8 feet] in height, the depth shall be not less than 600 mm [2 feet]. For balled and burlapped stock enough additional depth shall be added to provide room for an 200 mm [8 inch] depth of backfill material under the bottom of the ball. In all cases the depth shall be sufficient to contain all the roots of the plant without crowding.

In certain areas of poor drainage or heavy soil the Engineer may require raising the plant elevation or have the soil excavated from the plant pit spread on the ground adjacent to the pit and neatly distributed so as to raise the grade of the area to provide better surface drainage. Where shown on the plans or directed by the Engineer such pits may also require drains. When such drains are required they shall be included as a part of the cost of the plant.

- (d) Class B Planting. For Class B planting, plant pits shall be dug such that the diameter will be 250 mm [10 inches] greater than the maximum root spread and 150 mm [6 inches] deeper than the greatest root depth except that pits shall be dug not less than 200 mm [8 inches] deep for shrubs and vines and not less than 300 mm [12 inches] deep for all trees. Suitable loam existing at the site of the plant pit shall be excavated separately and used as backfill around the roots. The balance of the hole shall then be filled with any remaining subsoil. Stones larger than 75 mm [3 inches] in maximum diameter, large roots, roots or rhizomes of witch grass or other injurious materials shall be removed and not used as backfill. Any additional material needed to fill plant pits to the level of the surrounding ground shall be loam furnished by the Contractor at his own expense, and placed around the roots of the plant.
- (e) Class C Planting. Class C plants will be planted in the existing soil. Plant holes must be deep enough to allow room, for the full depth of the root without doubling or folding and wide enough to allow room for its normal spread. Plants must be set straight and at the same depth at which they were previously growing. Soil must be firmly compacted about the roots leaving no air pockets and liquid fertilized during planting only. In heavy sod the Engineer may require that the sod be removed or folded back to a distance of 100 to 150 mm [4 to 6 inches] from the main stem of each plant.

An artificial appearance is not desired. Care must be taken to avoid straight lines and too-uniform spacing. Some variation in spacing is essential except in the case of snow control planting where uniform spacing is required.

621.0020 Planting Seasons. Seasons for planting, unless otherwise directed, shall be within the following dates:

Bare Root Plants except Evergreen Seedlings	Spring - April 1st to May 31st Fall-September 15th to Nov.15
Evergreen Seedlings	April 1st to May 15th only
Potted & Container Grown Plants	Spring-April 1st to July 15th Fall-August 15th to Nov. 15th
Balled & Burlapped Plants	Spring-April 1st to June 15th Fall-August 15th to Oct. 15th

Preparations for planting may begin earlier than the specified season and planting work may continue beyond the specified time limits if approved by the Engineer. However, the Engineer may require that all plants planted out-of-season shall receive special attention as directed. Any out-of-season planting shall be at the Contractor's risk and expense.

621.0021 Notice of Delivery of Plants. Notice of Delivery of Plants shall be given by the Contractor to the Engineer at least 48 hours in advance of the anticipated date unless otherwise authorized.

621.0022 Handling and Care of Plants, All Classes.

- (a) Digging of plants shall be performed immediately before shipment. Care shall be taken to avoid injury to or loss of roots. Cutting of roots, where required, shall be done by workmen skilled in handling and care of plants. Plants required to be balled and burlapped shall be dug with a firm ball of earth encompassing the roots of the plant. B and B plants with loose or broken root balls will not be accepted.
- (b) Plants shall be protected before planting by keeping them moist and fresh, taking all necessary precautions against exposure to sun, wind and freezing temperatures.
- (c) Bare root plants shall be puddled in a wet organic or clay mixture which will adhere to all parts of the root system and shall be wrapped in wet straw, burlap or other approved material, immediately after digging.
- (d) Plants shall at no time be bound in a manner such as may cause damage to the bark, branches or roots or packed so tightly as to cause heating.
- (e) Care shall be taken in placing and handling to avoid injury or damage to the health of the plants. In transit and upon delivery, protection shall continue until the material is planted. Wet cloth, wet straw, or other approved material shall be used to protect plants at all times. Bare roots of plants shall not be exposed to sun and wind for periods of more than 5 minutes at any stage of handling or planting. Upon delivery to the job site all plants not to be planted within 24 hours must be placed in some form of approved storage. Plants with wind damaged or wilted foliage due to

open and exposed transport are unacceptable for planting and will not be allowed to recover in plant pits.

- (f) Storage of plants on the project will preferably be in approved buildings where they are protected from heat, light and wind. Plants will be placed in a vertical position and the roots of individual plants or plant bundles packed separately in wet sawdust, peat moss or other approved material. Plants and packing material must be kept damp at all times. If indoor storage is not considered satisfactory by the Engineer, he may require that all plant material be moved outside and properly heeled in, irrigated, planted immediately, potted or otherwise treated to keep it in a healthy condition. Inside storage will not be considered satisfactory after new growth has started.

If outside storage is used, all bare root stock shall be heeled in trenches after opening the bundles and spacing the plants separately. All roots shall be promptly and carefully covered so as to eliminate air pockets. Balled material shall have the balls completely covered with wet sawdust, peat moss or other approved material. All plants shall be kept thoroughly watered at all times.

- (g) All willow and poplar trees as well as Cornus Alba will be thoroughly sprayed on the project with a fungicide approved by the Engineer before being planted regardless of whether they show signs of disease or not. No plants of these species will be allowed on the job which have not received this treatment. A second spraying will be required after the plants are planted when and as directed by the Engineer.
- (h) Failure to comply with the above precautions may result in a poor survival rate for the mistreated plants. Such failure will be sufficient cause for rejecting any of the plants involved at any time. Rejected plants may be marked with paint for identification, should not be planted on the project, will not be paid for and must be replaced by approved plants as specified in Subsection 621.0003 or unless authorized.

621.0023 Setting Plants. The plants shall be set plumb and straight in the prepared pits and beds and at a level such as will result, after settlement, in a normal relationship between the plant and the surrounding ground surface.

621.0024 Backfill Class A and Class B. For all Class A plants backfill shall consist of 3 parts of loam thoroughly mixed with one part of peat humus. Loam shall be used for backfill around Class B plants insofar as it is available as excavation from the plant pit. Approved existing loam may also be used on Class A planting. However, sods or clods may not be used as backfill on either Class A or Class B plants. The roots of bareroot plant materials shall be placed in their natural arrangement with the backfilling carefully performed to prevent damage to the plant's root system. Broken or bruised roots shall be pruned immediately, making a clean cut. The backfill material shall be placed and compacted in the bottom of the planting pit and shall be worked around the roots and thoroughly compacted as the backfilling proceeds, leaving no air pockets. Balled and burlapped plants shall be carefully placed in prepared pits so that the balls rest on the compacted backfill material. The backfill shall then be filled in around the rootball to half the depth of the ball and tamped or watered in. The remaining burlap around the balls shall then be

loosened and spread out away from the plants or if it is too bulky, cut away and removed. The backfilling shall then be completed, watered and tamped firm. Burlap and plastic weave ball wraps may require slit openings to be cut. Plastic film wraps shall be completely removed during planting. Shallow basins or saucers of earth will normally be required to be placed around each plant as directed by the Engineer. However, when drainage conditions are poor, as in heavy clay soil, the Engineer may require that such saucers be omitted or used only temporarily. All plants shall be thoroughly watered and liquid fed the day they are planted and as often thereafter as the Engineer deems necessary for the plants to become safely established. If watering during the establishment period is unsatisfactory, no payment will be made.

621.0025 Fertilizing.

- (a) Water Soluble Fertilizer. The first liquid feeding will be permitted as the first watering only during backfilling of the plant, unless otherwise directed by the Engineer. All seedlings will be liquid fed during planting. The second liquid feeding will be made the following spring season, no later than June 30th.

Liquid fertilizer shall be completely dissolved and mixed in water at the rate of 3 kg [6 lbs.] of the fertilizer concentrate to 400 L [100 gallons] of water.

The resulting solution shall be poured in the plant pit as directed by the Engineer. A second application at the same rates shall be applied to Class A and Class B plants as directed by the Engineer. The solution shall be applied at the following rates for each application:

Class C evergreen plants-0.5 L [1 pint] per plant
Class C deciduous plants-2 L [2 quarts] per plant
Class A and B plants-plants up to 600 mm [2 feet] in height shall receive 3.4 L [4 quarts]. Plants above 600 mm [2 feet] and up to 1800 mm [6 feet] shall receive 6 L [6 quarts]. Plants above 1800 mm [6 feet] and up to 3600 mm [12 feet] shall receive 11 L [12 quarts]. Plants above 1800 mm [12 feet] shall receive 15 L [16 quarts].

- (b) Slow Release Fertilizer Packets. All woody plants except evergreen seedlings shall be fertilized with slow release fertilizer packets at the time of planting, unless otherwise directed by the Engineer. Fertilizer packets shall be placed equidistantly within the planting pit adjacent to the ball or root mass, but not in direct contact with roots. Placement depth shall be 150 to 200 mm [6 to 8 inches] below ground level. Packets shall not be cut, ripped or damaged.

If it becomes necessary to remove and replace dead or unhealthy plants, damaged or broken packets shall be replaced with new packets.

The application rates shall be as follows:

<u>Types of Plants</u>	<u>No. of Packets</u>
Evergreen Trees	
Under 450 mm [18 inches] height	1 packet
450 mm to 900 mm [18 inches to 3 feet] height	2 packets
900 mm to 1800 mm [3 feet to 6 feet] height	3 packets
Over 1800 mm [6 feet] height	4 packets
Deciduous Trees	
Under 1800 mm [6 feet] height	2 packets
1800 mm to 3600 mm [6 feet to 12 feet] height or under 100 mm [4 inches] caliper	3 packets
Over 100 mm [4 inches] caliper	4 packets
Shrubs	
Under 600 mm [2 feet] height or spread	1 packets
600 mm to 900 mm [2 feet to 3 feet] height or spread	2 packets
Over 900 mm [3 feet] height or spread	3 packets
Vines and Ground Covers	1 packet

621.0026 Mulching. The disturbed surface area of plant beds shall be evenly and uniformly covered to a depth of 75 mm [3 inches] with stone or 100 mm [4 inches] with wood chip or bark mulch as indicated on the plans or Subsection 621.0019(a) or as directed by the Engineer.

Plant pits for individual plants shall be similarly covered except that perennials and Class C plants shall have mulch 50 mm [2 inches] deep and the mulch shall extend uniformly to a distance of 150 mm [6 inches] outside the edge of the approved plant pit dimension on all sides. Mulching will not be required on Class C evergreens, unless otherwise stated herein.

Where stone mulch is used, the level of the loam in the plants bed will normally be left 25 to 50 mm [1 to 2 inches] below the level of the surrounding ground. Excavation, loam backfill and planting shall be adjusted accordingly.

Measurement of the depth of mulch will be made after one heavy rain or after a three-week period without heavy rain.

Plastic membrane shall be laid in overlapping strips between the mulch and the surface of the backfill material. Each strip of membrane shall be 900 mm [three feet] in width and long enough to cover the entire width of the plant bed or pit. Plastic membrane shall be used on plant beds or pits as indicated on the plans or as directed by the Engineer.

All plant pits and beds must be entirely free of weed or grass growth and free of the roots of all grasses at the time mulch is applied.

When plant beds are installed near guardrails or as stated in Subsection 621.0019(a) the space between the plants and the guardrail or the nearest pavement when it extends in back of the guardrail, shall be treated as a part of the plant bed and shall be weeded and mulched.

Plants shall not be damaged when the mulch is applied. Smothered or otherwise damaged plants must be replaced. Mulch, in place, will not be permitted to be directly in contact with the base of plant trunks or stems in excess of 50 mm [2 inches] of thickness.

621.0027 Cultivation. All plant pits and beds shall be kept free of weeds and grass by the Contractor from the time the plants are planted until final acceptance. This shall be accomplished by manual weeding or cultivation. Chemical control of weeds or grass will not be allowed except upon written permission of the Engineer and then only at the Contractor's risk. There will be no payment for unsatisfactory work.

621.0028 Supporting of Trees. All deciduous trees over 25 mm [1 inch] in caliper or over 1800 mm [6 feet] in height shall be staked or guyed immediately after planting. Support stakes, in place, shall have an above ground height in excess of two thirds the planted height of the trees.

- (a) Deciduous trees up to 2400 mm [8 feet] in height and evergreens 900 to 1500 mm [3 to 5 feet] high shall be supported by two posts placed on opposite sides of the tree or as directed by the Engineer. Posts shall be firmly set at least 600 mm [24 inches] into the ground and as close to the tree trunk as possible without injuring the roots. Normally this distance will not be more than 200 mm [8 inches]. The top portion of the stake shall be fastened to the tree by plastic chain-lock tree support ties secured to the posts with approved nails or stapled in such a manner as to prevent injury to the tree.
- (b) Deciduous trees 2400 to 3600 mm [8 to 12 feet] in height and evergreens 1500 to 2400 mm [5 to 8 feet] shall be staked with two posts placed on opposite sides of the tree and set firmly at least 600 mm [24 inches] in the ground. The posts shall be as close to the tree trunk as possible without causing injury to the roots for bare root stock and at the perimeter of the ball for B and B stock. The top portion of the stakes shall be fastened as in (a) above.
- (c) All larger trees shall be guyed with three guys arranged evenly about the tree. Guys shall consist of two strands of wire twisted together until taut. Guys shall be attached to the bole of the tree directly above a substantial limb at a height of 1/2 to 2/3 the height of the tree and attached to stakes firmly driven into the ground at such a distance from the tree that the guy wires shall be at an angle of approximately 45 degrees with the ground. The wire used for guying or staking shall be passed through a piece of garden hose of sufficient length and thickness as to prevent cutting or chafing of the bark of the trunk or branches. Stakes shall not project more than 200 mm [8 inches] above the ground. Where guy wires may be a hazard to pedestrians or be too difficult to install, the Engineer may require that 3 or 4 posts shall be used instead.

Where required by the Engineer, a strip of approved, durable white or red cloth 50 mm [2 inches] wide and 450 mm [18 inches] long shall be firmly tied to each guy wire at a point approximately 750 mm [2½ feet] above finished grade.

621.0029 Wrapping. Wrapping shall be placed around all trunks of deciduous trees 25 mm or more [1 or more inches] in caliper or as directed by the Engineer. The wrapping shall start at the base of the tree and shall cover the entire trunk surface terminating at the first branches. The wrapping shall be tied at top, bottom, and at intervals of not more than 600 mm [2 feet]. Wrapping shall be done at the time of planting but not before inspection of the plant is completed.

621.0030 Pruning. Pruning shall be done to each plant individually in such a manner as to preserve the natural character of the plant and shall be done only after delivery and inspection. All pruning shall be done with sharp tools by experienced men in accordance with the best horticultural practice. Plants pruned in such a manner as to seriously impair the appearance or character of the plant will be rejected. Bench pruning with knives or axes will not be permitted.

Broken or badly bruised branches, soft wood, and sucker growth shall be removed with clean cuts. Cuts over 20 mm [3/4 inches] in diameter shall be painted with approved tree wound paint. The Engineer may require that one-third or more of the growth of deciduous plants be removed as well as substantial portions of the growth of evergreens.

However, excessive pruning shall not be accepted as a means of disposing of dead wood or unhealthy plants. Plants in such poor condition that they can only be revived by pruning of more than 1/3 or more of the growth will be considered unsatisfactory and will be rejected or reduced to an applicable pay item. At the time of final acceptance, all plants must be approximately the size called for in the specification, due to allowance being made for moderate pruning.

621.0031 Potted and Container Grown Plants

- (a) Plants Potted On the Job. In order to protect the health of bare root plants and extend the planting season, such plants may be set in approved pots of the grow-thru type before leaves have developed, using the same loam mixture as is used in the plant pits for Class A plants. The plants shall be pruned, in the approved manner, during the potting operation. Pot sizes shall be large enough to enclose the plant roots without crowding and without excessive root pruning. All pots and plants shall have prior approval for acceptance. At the time of potting, all plants shall receive water soluble fertilizer at the approved rate for that plant size. They shall also be watered regularly and receive proper care while remaining in the storage area prior to being planted. The plants shall be planted, pot and all, in pits and beds in the same manner as bare root plants. Plant pit dimensions, backfilling, fertilization mulching and cultivation shall be performed as specified for bare root plants of similar type and size. The space outside the pot, in the plant pit or bed, shall be filled with loam or backfill material for B and B stock as required and shall be carefully tamped in place so as not to leave any air pockets.

Potted plants will not be planted in place until they have at least 14 days to become established in the pots unless the Engineer directs otherwise.

All potting operations shall be carried out by the Contractor using plants delivered to the project as bare root plants and approved as acceptable by the Engineer.

Potted plants shall be handled, planted, maintained and replaced as specified for balled or bareroot plants.

- (b) Plants Supplied in Containers in place of B and B stock. Where there exists a scarcity of certain plants or it is desirable to extend the planting season, the Engineer may, allow the substitution of container grown plants for bare root or B and B stock. Such plants may be accepted with a root ball that is proportionately 25 percent less in size than the required root spread or ball size for such plants. However, such plants must have been established in containers at least one full growing season before planting and shall have a well rooted condition evidenced by the firmness of the mass of soil and roots. The outside of the ball of soil shall be well matted with healthy working roots, but shall not be pot bound. Plants shall be adequately hardened off before planting.

Containers shall be of such shape as to permit easy removal of the plant.

No plant will be accepted if the container ball is cracked or broken upon removal from the container.

621.0032 Herbaceous Plants.

- (a) Crown Vetch. Crown Vetch shall be 2 year old plants, furnished in pots, of not less than 55 mm [2¼ inch] diameter. Plants shall have been growing in the pots for not less than 1 full year and shall be heavy and vigorous, exhibiting a well rooted condition which is evidenced by a firm mass of soil and roots throughout the pot.

Crown Vetch plants will be planted in the existing soil. The soil shall be thoroughly loosened to a depth of 200 mm [8 inches] forming a planting pocket not less than 200 mm [8 inches] in diameter before the plant is set. The plants shall be watered at the time of planting and as required to keep them in as healthy growing condition the same as other plants. During planting, they shall be fertilized with water soluble fertilizer at the rate of 0.5 L [1 pint] per plant, per application. Each plant shall receive 10 ml [one heaping teaspoonful] of ground lime distributed evenly around the plant.

- (b) Daylilly. Daylilly plants shall consist of root clumps with a minimum diameter of 150 mm [6 inches] containing the full depth of the root. Each root clump shall contain not less than three live sprouts. It is expected that collected clumps of naturalized Daylilly will be used but the Engineer may, at his discretion, accept other hardy species or varieties.

Daylillies will be planted in holes 300 mm [12 inches] in diameter and 300 mm [12 inches] deep. They will be handled, planted, maintained and replaced as specified for Class A plants except for the following changes:

(1) Water Soluble Fertilizer shall be applied at the rate of 1 L [1 quart] per plant.

(2) Dry Fertilizer shall be applied at the rate of 0.2 L [1 cupful] per plant.

- (c) Monarda. Monarda plants shall consist of root clumps or rooted stolons previously planted in approved "grow-thru" type pots. Each root clump or stolon shall contain not less than four live shoots at the time of planting.

Monarda will be planted in holes 250 mm [10 inches] in diameter and 300 mm [12 inches] deep. They will be handled, planted, maintained and replaced as specified for Class A plants except for the following changes:

- (1) Water Soluble Fertilizer shall be applied at the rate of 1 L [1 quart] per plant.
 - (2) Dry Fertilizer shall be applied at the rate of 0.1 L [1/2 cupful] per plant.
 - (3) Mulch except where plants are too close together. Monarda beds shall be covered with a 50 mm [2 inch] depth of wood chip or other approved mulch.
- (d) Lupine. Lupine plants shall consist of well-rooted clumps, each containing not less than four main stems previously planted in approved "grow-thru" pots of not less than 150 mm [6 inch] diameter. Plants will be of hardy species and varieties having predominantly blue, pink or yellow flowers.

Planting and culture shall be the same as for Monarda.

- (e) Columbine. Columbine shall consist of hardy species and varieties having blue, yellow or pink flowers. Type of plant, and planting shall be the same as for Lupine.

621.0033 Protection From Rodents. The trunks of all deciduous trees over 12 mm [1/2 inch] caliper shall be protected to a height of at least 600 mm [24 inches] from the ground by plastic, wire mesh or other rodent proof protective material or similar devices approved by the Engineer. Protection shall start at ground level below the mulch. If wire mesh protectors are used they shall consist of standard galvanized steel wire hardware cloth having openings 6 mm [1/4 inch] square. They shall be set so that the trunk of the tree is approximately in the center of the circle formed by the wire with a clearance of at least 50 mm [2 inches] on all sides of the trunk. Edges of the wire mesh shall overlap at least 25 mm [1 inch] and shall be firmly wired together.

It will be the responsibility of the Contractor to take necessary steps to protect all plants from rodents during the life of the contract. Protection from rodents will be included in the cost of the individual plants and the Contractor will receive no extra compensation for this work. No payment will be made for unsatisfactory work during the establishment period or planting season.

621.0034 Cleanup and Repair. All excavated material and debris resulting from the planting operation shall be promptly disposed of outside of and out of sight of the project, unless otherwise directed by the Engineer. Any areas disturbed by the Contractor showing bare earth, that do not require mulching, shall be seeded with approved grass seed, fertilized and hay mulched, as directed by the Engineer.

The Contractor shall be responsible for any damage caused by his operations and shall restore the disturbed areas to their original condition. Cost of cleanup and repair shall be considered included in the payment for other items of the work.

621.0035 Prosecution and Progress. It is essential that each portion of the planting work in any area be promptly followed by cleanup of subsoil and debris, fertilization, watering, cultivation, pruning, mulching, staking, spraying as needed, repair and restoration of damage caused by the Contractor, etc. The Contractor shall provide sufficient labor and supervisory personnel to carry out this work without undue delay. Any delay in carrying out this phase of the work which, results either in danger to the health or growth of the plants or a poor appearance of the project from the point of view of the public will be considered due cause for withholding all or part of any payment due the Contractor for plants delivered and planted or for any other work done.

Partial payments on the contract do not constitute approval or acceptance of any specific plants or work operations. The right is reserved to reject any plants or work which are discovered to be unsatisfactory at any time prior to Final Acceptance.

621.0036 Establishment Period. The acceptability of the plant material furnished and planted under this contract shall be at the end of a period of establishment, during which the Contractor, as necessary, shall employ all possible means to preserve the plants in a healthy and vigorously growing condition and to insure their successful establishment. During this period the Contractor shall water, cultivate and prune the plants, repair guy wires and stakes, mouse bait as may be required and do any other work necessary to maintain the plants in a healthy growing condition. This shall include seasonal spraying with approved insecticides or fungicides as may be required. The Contractor shall also be responsible for protecting the plants from mice and other rodents. All dead or rejected plants shall be promptly removed from the project and replaced by live healthy plants meeting the same specifications. If such plants are declared unacceptable during the planting season, they shall be replaced during this planting season, otherwise, they shall be replaced during the next subsequent planting season. No payment shall be made for unsatisfactory work during the establishment period.

Such replacement plants are subject to the same requirements as the original plants and must be replaced in turn if they fail to meet the required standards. Plants designated for spring planting only, will be replaced only during the spring planting season unless otherwise directed by the Engineer.

The period of establishment shall commence at the end of each planting season as specified in Subsection 621.0020 and shall extend until one year after that date for all plants planted during that particular planting season unless otherwise directed. Necessary replacements shall be made so that at the time of Final Acceptance all plants shall be in a healthy, vigorous growing condition and free from sizeable die-back.

Replacements will be required for plants lost, damaged or rejected, whatever the cause. The Contractor will be considered responsible for the plants until the time of Final Acceptance.

It shall be the sole responsibility of the Contractor to replace any unsatisfactory plants on the project regardless of whether they are specifically designated by the Engineer. In the case of individual doubtful plants the Contractor may call upon the Engineer to make a determination as to their acceptability, but it shall not be incumbent on the Engineer to furnish the Contractor with exact lists of replacements.

All replacements of plants shall be completed by the end of the planting season prior to the Final Acceptance date. Any small quantity of plants which fail between the end of the planting season and the Final Acceptance date shall be cancelled from the list of accepted plants and the Contractor will receive no payment for them. If a sizeable number fails the Engineer may extend the date of Final Acceptance to the subsequent planting season, in which case, the Contractor will be subject to liquidated damages. All replacement planting shall conform in every way to the requirements of the original planting. The Engineer may require that any replacement plants that are not dormant, or that are planted late in the season, be sprayed, as directed with an approved anti-desiccant.

621.0037 Method of Measurement. The quantity of plants to be measured for payment will be the number of individual plants furnished and planted as required and accepted, excluding replacements.

621.0038 Basis of Payment. Each item of "Planting" will be paid for at the contract unit price for each accepted plant furnished and planted. Payment shall constitute full compensation for; furnishing and placing plants, digging, delivering, rodent protection, preparing plant pits, beds and drains; planting, watering, fertilizing, supporting, mulching, pruning, establishing and the cleanup of planting areas; for all loam, fertilizer, mulch and other necessary materials; all labor, equipment, tools and any other incidentals necessary to complete the work.

When a bid item calls for a "Group" of trees, shrubs, vines or other plants, the Contractor shall furnish each individual species within this "Group" for the same unit bid price.

The name and estimated number of individual species within each "Group" will be shown on the estimated quantities sheet of the plans.

Payment will be made under:

Pay Item	Pay Unit
621.... Name plant or plant group as detailed in Schedule of Items in Proposal Book	Each

SECTION 622 -- TRANSPLANTING SHRUBS, HEDGES AND TREES

622.01 Description. This work shall consist of digging, moving and replanting existing shrubs, hedges and trees in accordance with these specifications and in conformity with the plans or as directed.

MATERIALS

622.02 Loam. Loam shall conform to the requirements of Subsection 615.02. Fertilizer shall meet the requirements specified in Subsection 717.01.

CONSTRUCTION REQUIREMENTS

622.03 Shrubs and Hedges.

- (a) Digging. The earth of shrubs and hedges to be moved shall be carefully encompassing the roots as is customary in good nursery practice. Minimum size of the rootball shall be as indicated in the current edition of the "American Standard for Nursery Stock" sponsored by the AAN.
- (b) Moving. The earth rootball shall be maintained as a solid unit during the moving of the shrubs and hedges and must be protected from breaking or cracking by careful handling. The rootball shall be tightly wrapped with burlap or similar material. Earth rootballs greater than 450 mm [18 inches] in diameter shall be tightly bound with cord or rope placed over the burlap unless the shrubs or hedges are to be replanted immediately after digging.
- (c) Planting. The plants shall be planted in the designated new location at the same depth below ground surface as before they were moved. Loam shall be placed to a thickness of not less than 200 mm [8 inches] under and around the rootball to eliminate all air pockets and to support the plant. Insofar as feasible, when hedges are to be transplanted, the individual plants shall be replanted in the same relationship to each other that existed before they were moved.

Fertilizer shall be mixed evenly into the backfill soil at the rate of 0.4 kg per meter [1/4 of a pound per foot] of height for each plant. Water soluble fertilizer and slow release fertilizer packets shall be applied at the following rates.

Shrubs to 600 mm [2 feet] high or spread	4 L[4 quarts] water soluble or 1 packet
Shrubs to 1200 mm [4 feet] high or spread	6 L[6 quarts] water soluble or 2 packets
Shrubs to 1800 mm [6 feet] high or spread	8 L[8 quarts] water soluble or 3 packets

- (d) Time of Transplanting. Plants shall be dug and transplanted only when dormant, preferably in the early spring, unless otherwise directed by the Engineer. When dug, shrubs and hedges shall be moved directly to the final planting site and planted without delay, if possible. The rootball must be kept moist at all times during transplanting operations. If construction makes it impossible to replant the plants immediately after digging, the rootballs of the plants shall be kept completely

covered with a thick layer of earth, hay, peat moss, or similar material which shall be kept moist at all times while the plants remain unplanted. Shrubs may be held in approved pots under conditions of delayed replanting.

- (e) Pruning. All pruning shall be done in accordance with the best horticultural practice. Dead, diseased or injured shoots and branches shall be removed. In order to restore a normal balance between top and roots, deciduous shrubs shall be thinned by removing uniformly scattered, selected branches which shall be cut back to the main stem, as directed. The Engineer may also require tip pruning. Tip pruning may also be required for evergreens. In the case of hedges, the Engineer may require shearing to uniform, even surfaces.
- (f) Watering. As soon as the plants are planted they shall be thoroughly watered to the point where the roots and the surrounding earth are well saturated. The first application of liquid fertilizer shall be made during planting.
- (g) Mulch. After removing all weeds and grass, the ground surface over the entire area of the planting pit shall be covered to a depth of 75 mm [3 inches] with a mulch of wood chips, stone or other approved material. Sawdust, hay or straw will not be accepted as mulching material.

622.04 Trees.

- (a) Digging. All trees to be moved and replanted shall be dug with a solid ball of earth around the roots as is customary in good nursery practice. The diameter of the ball shall be not less than 10 times the diameter of the trunk of the tree measured 300 mm [1 foot] above the surface of the ground. Depth of the ball shall be not less than 60 percent of its diameter for balls up to 1200 mm [48 inch] diameter. For balls over 1200 mm [48 inch] diameter the ball shall have sufficient depth to maintain a solid structure and to encompass all the feeding roots under the ball area. Power shovels and similar machinery may not be used in digging the ball except with written permission.
- (b) Moving. The ball must be maintained as a solid unit during the moving of the tree. The ball must be protected from breaking or cracking by careful handling and by being tightly bound with cord or rope over canvas, burlap or similar wrapping. The ball shall be firmly attached to a tree platform of suitable size during moving operation, as required.
- (c) Planting. The trees shall be planted in the designated new location at the same depth in relation to the ground surface as before they were moved. Loam shall be placed to a distance of not less than 300 mm [12 inches] under the ball and around the periphery of the ball. Loam shall be puddled and firmed in place to eliminate all air pockets and give adequate support to the ball. Fertilizer shall be applied as specified in Subsection 621.0025(b).
- (d) Protection. Every care shall be taken to prevent injury to the tree during the transplanting operation. All parts of the tree shall be carefully protected. Branches shall be tied out of the way of possible injury. No chain, cable or heavy rope may

be attached to the trunk or branches without protective padding adequate to prevent bruising or other injury.

- (e) Time of Transplanting. Trees shall be dug and transplanted only when dormant, preferably in the early spring, unless otherwise directed. When dug, trees shall be moved directly to the final planting site and planted without delay if possible. The ball must be kept moist at all times during transplanting operations. If construction problems make it impossible to replant the tree immediately after digging, the ball of the tree must be completely covered with a thick layer of earth, hay, peat moss or similar material which shall be kept moist at all times while the tree remains unplanted. Pruning, watering, fertilizing, mulching and supporting shall be as specified in the applicable Subsections of Section 621 -- Landscaping.

622.05 Maintenance. It shall be the Contractor's responsibility to protect and care for the plants during the life of the contract. They shall be watered weekly during dry weather or as otherwise directed. The Contractor shall take steps required to protect the plants from damage and from diseases and insect pests. Should damage occur it shall be repaired by the Contractor, according to the best horticultural practice.

622.06 Replacement. If the ball is badly broken or the plants are otherwise badly damaged or if, in the opinion of the Engineer, during the life of the contract the plants show such signs of loss of health or appear to be in danger of dying, the Contractor will be required to replace the plants with others of the same size and variety or approved plants of equal value, at the proper season.

622.07 Method of Measurement. Transplanting hedges will be measured by the meter [linear foot] in place after transplanting, measured from the extremities of the branches at each end. A hedge shall be defined as an evenly spaced row of plants of uniform size, growing close to each other so that the branches are intermingled.

Transplanting shrubs or trees will be measured in place after transplanting by the single shrub or tree unit.

622.08 Basis of Payment. The accepted quantities of transplanting hedges will be paid for at the contract unit price per meter [linear foot] of hedges properly transplanted and accepted, which price and payment shall include digging, binding, moving, replanting, pruning, mulching, care and maintenance and if required, replacement of the hedges and for all loam, mulch and all other materials and incidentals necessary to complete the item.

The accepted quantities of transplanting shrubs or trees will be paid for at the contract unit price for each plant properly transplanted and accepted, which payment shall include digging, binding, moving, replanting, pruning, mulching, care and maintenance and if required, replacement of the shrubs, and for all loam, mulch and other materials, and for all incidentals necessary to complete the item.

Payment will be made under:

Pay Item	Pay Unit
622.09 Transplanting Hedge	meter [Linear Foot]
622.10 Transplanting Shrub	Each
622.11 Transplanting Tree	Each

SECTION 623 -- MONUMENTS

623.01 Description. This work shall consist of furnishing and placing, or removing and resetting right-of-way monuments and survey monuments at locations shown on the plans or otherwise designated.

MATERIALS

623.02 Materials. Monuments shall be of granite or of reinforced portland cement concrete. When of granite, the stone shall be of a quality conforming to the applicable requirements of Subsection 712.04. When of portland cement concrete, they shall be of Class "AA" concrete as specified in Section 502 -- Structural Concrete. Reinforcement shall conform with the requirements of Section 503 -- Reinforcing Steel.

CONSTRUCTION REQUIREMENTS

623.03 General. Monuments shall be placed in vertical positions in excavated holes at depths shown on the plans or designated, with two sides approximately parallel with the roadway. The backfill material shall be placed in layers not exceeding 200 mm [8 inches] in depth, loose measure and firmly tamped.

When removing and resetting monuments, special care shall be taken that the stone shall not be broken or damaged. Monuments broken or damaged by the Contractor shall be replaced with monuments of similar type without added compensation.

When a monument is to be set and it is found that rock exists below ground, it will be permissible to cut off the monument at an authorized length to allow setting on the rock. A concrete collar with dowels shall be placed around the monument to secure it to the rock, as shown on the plans. If the rock is rough enough to provide firm attachment for the concrete, collar dowels will not be necessary. The concrete shall meet the requirements of Section 502 -- Structural Concrete. The class of concrete shall be optional.

When a monument is to be set in the surface of exposed rock it may consist of a bronze pin marker embedded in the ledge as shown on the Standard Detail Sheets.

623.04 Method of Measurement. Monuments and markers, both new and reset, will be measured by each unit. Excavation in solid rock will be measured by the cubic meter [cubic yard] determined from the actual depth of the hole and a hypothetical circle diameter of 600 mm [2 feet].

623.05 Basis of Payment. The accepted quantities of monuments and markers will be paid for at the contract unit price each complete in place. Payment for placement of monuments in solid rock shall be considered included in the contract unit bid price except that actual excavation into solid rock will be paid for under Pay Item 206.07, Structural Rock Excavation, Drainage and Minor Structures.

Payment will be made under:

Pay Item	Pay Unit
623.06 Right-of-Way Monument	Each
623.07 Survey Monument	Each
623.08 Bronze Pin Marker	Each
623.09 Remove and Reset Monument	Each

SECTION 624 -- VACANT

SECTION 625 -- WATER SERVICE SUPPLY LINES

625.01 Description. This work shall consist of installing water pipe and pipe sleeve in reasonably close conformity with the lines and grades shown on the plans or established. The installation shall include the assembly of all components and materials shown on the plans or as directed.

MATERIALS

625.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Copper Tubing	712.32
Non-metallic Pipe, Flexible	712.33
Non-metallic Pipe, Rigid	712.34
Metallic Pipe	712.341

CONSTRUCTION REQUIREMENTS

625.03 General. This work shall be done with as little interruption of water service as possible. Ample notification shall be given to the users of the water before any disruption of water service.

625.04 Sleeve. Pipe for sleeves shall be metallic or non-metallic rigid and be laid on a firm foundation at the line and grade designated. When the pipe installation is in a trench all excavating and backfilling shall be in accordance with Section 206 -- Structural Excavation.

After installation of the pipe, special care shall be taken to protect the pipe from heavy hauling equipment loads, rocks or any other damage caused by the Contractor's work. All pipe broken from such causes shall be removed and replaced at the Contractor's expense.

Pipe sleeves to be placed in concrete shall be supported during placement of concrete. Special care shall be taken while placing and compacting concrete around the sleeves to prevent voids around the outside of the sleeves. Ends of the sleeves shall be capped with end plates until the water pipes are installed through the sleeves.

625.05 Water Pipe. Water pipe shall be copper tubing or non-metallic flexible pipe, as called for. After the sleeve has been placed the water pipe shall be inserted into the sleeve and connected to the existing pipes at each end. All connections to existing pipes shall be done in accordance with recognized plumbing practices. Necessary fittings, adapters, and reducers shall be furnished as required.

625.06 Method of Measurement. Pipe sleeve, copper tubing and non-metallic pipe will be measured by the meter [linear foot].

625.07 Basis of Payment. The accepted quantities of pipe sleeve, copper tubing and non-metallic pipe will be paid for at the contract unit price per meter [linear foot] for the types and sizes specified complete in place, which payment will be compensation for furnishing and installing all necessary fittings, for connecting to existing systems and for capping the ends of the pipe sleeve.

Excavation will not be paid for separately but will be considered included in the work of the contract items.

Payment will be made under:

Pay Item -	Metric Units	Pay Unit
625.081	19 mm Copper Tubing	meter
625.082	25 mm Copper Tubing	meter
625.083	32 mm Copper Tubing	meter
625.084	38 mm Copper Tubing	meter
625.085	44 mm Copper Tubing	meter
625.086	50 mm Copper Tubing	meter
625.09	Vacant	

625.101	19 mm Non-metallic Pipe-Flexible	meter
625.102	25 mm Non-metallic Pipe-Flexible	meter
625.103	32 mm Non-metallic Pipe-Flexible	meter
625.104	38 mm Non-metallic Pipe-Flexible	meter
625.105	44 mm Non-metallic Pipe-Flexible	meter
625.141	50 mm Pipe Sleeve	meter
625.142	75 mm Pipe Sleeve	meter
625.143	100 mm Pipe Sleeve	meter
625.144	150 mm Pipe Sleeve	meter
625.145	200 mm Pipe Sleeve	meter

Pay Item - English Units Pay Unit

625.081	3/4 inch Copper Tubing	Linear Foot
625.082	1 inch Copper Tubing	Linear Foot
625.083	1 1/4 inch Copper Tubing	Linear Foot
625.084	1 1/2 inch Copper Tubing	Linear Foot
625.085	1 3/4 inch Copper Tubing	Linear Foot
625.086	2 inch Copper Tubing	Linear Foot
625.09	Vacant	
625.101	3/4 inch Non-metallic Pipe-Flexible	Linear Foot
625.102	1 inch Non-metallic Pipe-Flexible	Linear Foot
625.103	1 1/4 inch Non-metallic Pipe-Flexible	Linear Foot
625.104	1 1/2 inch Non-metallic Pipe-Flexible	Linear Foot
625.105	1 3/4 inch Non-metallic Pipe-Flexible	Linear Foot
625.141	2 inch Pipe Sleeve	Linear Foot
625.142	3 inch Pipe Sleeve	Linear Foot
625.143	4 inch Pipe Sleeve	Linear Foot
625.144	6 inch Pipe Sleeve	Linear Foot
625.145	8 inch Pipe Sleeve	Linear Foot

SECTION 626 -- FOUNDATIONS, CONDUIT AND JUNCTION BOXES FOR HIGHWAY SIGNING, LIGHTING AND SIGNALS

626.01 Description. This work shall consist of furnishing, installing, modifying or removing concrete foundations, conduits and junction boxes for highway lighting, highway signing and traffic signal installations in accordance with these specifications and in reasonably close conformity with the plans.

MATERIALS

626.02 General. The materials furnished by the Contractor shall be new. Where an existing system is to be modified, the existing material shall be removed and abandoned or salvaged as shown on the plans or as directed.

All electrical equipment shall conform to NEMA or UL standards, wherever applicable. In addition to these requirements, all materials and workmanship shall conform to the requirements of: NEC, ASTM Standards, the ANSI, the local electrical utility and any local ordinances which may apply.

Materials shall meet the requirements specified in the following Subsections of Division 700, Material Details.

Reinforcing Steel	709.01
Precast Concrete Units	712.06
Steel Conduit	715.02
Non-metallic Conduit	715.03
Prewired Conduit	715.04
Metallic Junction and Fuse Box	715.05
Anchor Bolts	720.07

626.021 Miscellaneous Material. Gravel backfill shall meet the requirements for Aggregate Base-Screened, Subsection 703.06(a), Type A.

Transformer pads shall conform to the requirements of the local electrical utility.

If grouting is necessary to correct surface irregularities in the top of the concrete foundations, a non-shrink material satisfactory to the Engineer shall be used.

All concrete foundations shall be constructed of Class A concrete in accordance with the applicable requirements of Section 502 -- Structural Concrete.

626.022 Equipment List and Drawings. Unless otherwise permitted in writing, the Contractor shall within 30 days following execution of the contract, submit a list of equipment and materials which are to be installed. The list shall include the name of manufacturer, size and identifying number of each item. The list shall be supplemented by such other data as may be required, including detailed scale drawings of proposed minor deviations from the plans. If requested, the Contractor shall submit for review, design data and sample articles of the material proposed for use. All of the above data shall be submitted in duplicate except samples for testing. Following checking, correcting and reviewing, two complete sets of drawings shall be submitted. The Department will not be liable for material purchased, labor performed, or work delayed prior to such review.

Upon completion of the work, the Contractor shall submit three complete sets of corrected plans showing all construction changes.

CONSTRUCTION REQUIREMENTS

626.03 General. All work shall conform to NEC and NESC standards as set forth in the NIST Handbook H-32, except when otherwise noted on the plans or in the Special Provisions.

The Contractor shall be responsible for and shall repair all damage caused to underground drainage structures, utilities or lighting conduit which are encountered during construction.

626.031 Conduit. If the trench for conduit is located in wet, spongy or otherwise unsuitable ground, the trench shall be further excavated to a depth sufficient to overcome this condition and shall be backfilled with approved gravel. The gravel shall be compacted in layers not exceeding 200 mm [8 inches], loose measure. The grade of the bottom of the trench shall be parallel to the proposed grade of the conduit.

Trenches for conduits shall be excavated to a width which will permit proper installation of the conduit and to the depth shown on the plans or as directed.

Junction or pull boxes shall be installed as shown on the plans.

Where conduits enter exposed junction boxes, they shall be sloped to drain towards the conduit entrance holes, unless otherwise directed. Weepholes of 6 mm [1/4 inch] diameter shall be placed in all pull boxes, junction boxes and fuse boxes.

After the trench has been excavated as specified, the bottom of the trench shall be prepared with a sand bedding material. After placing the conduit, sand shall be placed around the sides and over the top of the conduit, when shown in the special details. The entire trench shall then be backfilled with approved material, placed in layers not exceeding 200 mm [8 inches], and thoroughly tamped.

All underground conduit shall be placed to at least the depth shown on the plans and shall not interfere with poles, guardrail posts, sign foundations or other objects.

All conduit ends shall be capped with conduit caps until wiring has begun. Prewired conduit shall be sealed during construction to prevent entry of moisture, dirt or rocks.

The size and type of conduit required will be noted on the plans, except that the minimum size of conduit risers required for traffic signal installations shall be determined by percentage fill in a single conduit, as specified in the latest revision of the NEC. Where more than one conduit is required to be installed in the same location, the conduits may be placed in the same trench.

The weatherhead on conduit risers on utility company poles shall not be less than 300 mm [1 foot] from the utility wires. Conduit risers on utility poles shall be located as required by the utility company.

Within 10 days after completion of each section of conduit, the Contractor, in the presence of the Engineer, shall rod and pull through each duct a mandrel and brush of a pattern satisfactory to the Engineer, but which shall not be more than 3 mm [1/8 inch] smaller than the bore of the ducts. Where obstructions in the ducts prevent passage of the mandrel, the Contractor shall, at his own expense, remove and relay those portions of the ducts necessary to clear the obstruction.

The Contractor shall install Number 9 US Steel Wire Gauge galvanized iron pull-wire in all unused conduits. The ends of the wire shall be secured in such manner as to prevent accidental withdrawal of the wire.

626.032 Metallic Conduit Installation. Conduits shall be of the sizes noted on the plans which are indicated as the nominal inside diameter. All conduits shall be joined with threaded couplings using approved thread sealant. Conduit shall be installed so that it is continuous and watertight between boxes or equipment. Running threads will not be permitted. When necessary, the Contractor shall use an approved electrical union-type coupling. Conduits shall be protected at all times from the entrance of water or other foreign matter. Conduit runs shall be made with as few couplings as standard lengths will permit. The total angle of all bends in one run and the radius of conduit bends shall conform to the NEC requirements. All field bends and offsets shall be made with approved hickey or conduit benders. Pull boxes shall be used wherever necessary to facilitate the installation of the wires.

In making up a run of conduits, all cut ends shall be reamed to remove rough edges and cut threads shall be painted with an approved thread sealant in such a manner that there will be no unprotected surfaces and joints will be watertight. All conduits shall have electrical continuity and shall be adequately grounded.

Conduits to be placed in the concrete superstructure of bridges and similar structures shall be securely supported and fastened, in order to maintain the conduits' position within the concrete superstructure, as shown on the plans. Pull boxes shall be located as shown on the plans. Clearance between conduit runs shall preferably be 50 mm [2 inches], but shall at no time be less than the maximum size of the aggregate used in the embedding concrete. At all joints where relative movement between adjacent parts of a structure can occur, a double "O"-ring expansion coupling, or other approved expansion device shall be installed.

Exposed conduit shall be rigidly and securely fastened with acceptable fasteners or supports, as indicated on the plans or approved. Fasteners or supports shall not be placed more than 1800 mm [6 feet] apart on centers, except as otherwise authorized. Conduits shall generally be supported by an approved spacer at the point of support, so that there is an air space between the conduit and the supporting surface. Ends of conduit runs terminating in a metallic box without a threaded hub shall be provided with a metallic locknut on the outside of the box, and a metallic locknut and insulated bushings on the inside. A lock washer and a galvanized steel flat washer shall be installed between the outside locknut and face of the box.

626.033 Polyvinylchloride Conduit Installation. Polyvinylchloride conduit, hereafter called PVC conduit, shall be installed in accordance with the applicable methods as specified in Subsection 626.032 for metallic conduits.

PVC conduit shall be made watertight by joining with solvent or in accordance with the manufacturer's specifications.

Conduit shall be bent carefully to avoid damage and without the use of an open flame. Bends sharper than 45 degrees (1/8 bends) will not be permitted in PVC conduit. The total angle of all bends in one run and the radius of bends shall conform to the NEC requirements.

Conduits to be placed in the concrete superstructure of bridges and similar structures shall be securely supported and fastened, in order to maintain the conduits' position within the concrete superstructure, as shown on the plans. Pull boxes shall be located as shown on the plans. Clearance between conduit runs shall preferably be 50 mm [2 inches], but shall at no time be less than the maximum size of the aggregate used in the embedding concrete. At all joints where

relative movement between adjacent parts of a structure can occur, a double "O"-ring expansion coupling, or other approved expansion device shall be installed.

To allow for expansion and contraction of PVC conduit during installation of long runs, one end shall be left unconnected or a double "O"-ring expansion coupling shall be inserted near one end of the run until final covering of the conduit is in progress.

Where PVC conduit runs are placed parallel to other conduit runs or cross one over another, they shall be separated by a minimum of 75 mm [3 inches] of sand or soil cushion. The bottom of trenches for PVC conduit shall be lined with a 75 mm [3 inch] minimum bedding of tamped sand or soil prior to laying the conduit. Backfill to a compacted depth of 150 mm [6 inches] above the top of the conduit shall be sand or soil, free from rocks or hard lumps.

At locations shown on the plans, or otherwise designated, conduit shall be constructed of schedule 80, PVC non-metallic conduit pipe encased in approved granular material as shown on the detail sheets.

When prewired conduit is installed, only those junction boxes necessary for underground splices shall be installed, unless otherwise directed.

Conduit and wire sizes of prewired conduit shall be as shown on the plans.

If the Contractor elects to plow-in the prewired conduit, the plowing shall be done with approved vibratory plowing equipment.

When prewired conduit is installed in a trench, the trench shall be prepared as previously noted in this subsection for PVC conduit.

626.034 Concrete Foundations. Prior to placing concrete, the required elbows of entrance conduits, reinforcing steel and anchor bolts shall be carefully positioned. The anchor bolt size and the bolt circle diameter shall be determined from data furnished by the supplier of the poles or as shown on the plans. Anchor bolts for use with breakaway couplings, longitudinally grooved-type, shall be 25 mm [1 inch] diameter and shall project between 65 to 75 mm [2½ and 3 inches] above the top of the foundation. All other anchor bolts shall be a minimum of 25 mm [1 inch] diameter and shall project sufficiently to accommodate the thickness of the base plus all nuts and washers. The bolt length shall also be sufficient to allow clearances of approximately 13 mm [1/2 inch] below the leveling nut and 6 mm [1/4 inch] above the top nut. At least two threads on each anchor bolt shall project beyond the outside of the nuts holding the plumbed pole.

Foundations shall be constructed of reinforced concrete with anchor bolts in accordance with the applicable requirements of Section 502 -- Structural Concrete, Section 503 -- Reinforcing Steel and in conformity with the dimensions and details shown on the plans or the Contractor's approved design.

If the foundation is located in wet, spongy or otherwise unsuitable material, the hole shall be further excavated to a depth sufficient to overcome this condition and backfilled with aggregate subbase material. The aggregate material shall be firmly compacted in layers not more than 200 mm [8 inches], loose measure. Backfilling of foundation material shall conform to Subsection 206.03.

The surface area around the foundations shall be loamed and seeded in accordance with the requirements of Section 615 -- Loam and Section 618 -- Seeding Method Number 2.

Concrete foundations designated to be modified or removed shall be modified or removed as shown on the plans. Debris resulting from the modification or removal shall be removed. After removal has been completed, the area shall be brought to grade by addition of granular material and loam, or by loam only, depending on the extent of modification or removal. The area shall then be seeded in accordance with Section 618 -- Seeding Method Number 2.

Backfilling around the foundations shall conform to the requirements of Subsection 206.03. Backfill material shall be excavated material, unless considered unsatisfactory, in which case the material used for backfill shall meet the requirements of Aggregate Base-Screened. The finished ground at each foundation shall be graded flush with the top of the foundation, except at locations where the foundation is protected by guardrail. If required, approved backfill material shall be added to grade the slopes as specified. There will be no additional compensation for furnishing, placing and compacting material flush around the foundation.

When solid rock is encountered at less than the required distance below existing ground level, the construction method shown on the plans shall be followed.

The concrete portion of the foundations exposed to view shall have a troweled finish. A drainage groove shall be formed in the horizontal surface of the foundation. The top of the concrete foundation shall be horizontal.

When the anchor bolt template is removed, the threads of the anchor bolts shall be greased and protected with a metal sleeve, held in position with nuts and washers to be furnished with the bolts. This thread protection shall remain in place until the pole or other equipment is installed.

A copper-clad steel ground rod shall be installed when shown on the plans.

626.04 Method of Measurement. Precast Concrete Junction Box, Foundations (all) and Remove or Modify Concrete Foundation will be measured by each unit.

All conduit will be measured by the number of meters [linear feet].

The quantity of structural earth excavation to be measured for payment below grade will be the amount actually excavated from 300 mm [1 foot] below the bottom of the foundation, junction box or sand bedding to the required elevation, provided the maximum allowable horizontal dimensions do not exceed those bounded by vertical surfaces 230 mm [9 inches] each side of the installation, as shown on the plans. The quantity of structural rock excavation to be measured for payment will be the number of cubic meters [cubic yards] actually removed, provided the maximum allowable horizontal dimensions do not exceed those bounded by vertical surfaces specified herein.

626.05 Basis of Payment. The accepted quantity of foundations will be paid for at the contract unit price each for the number of foundations of the respective types. This payment shall include: anchor bolts, reinforcing steel, conduit within the foundation and extending 300 mm [12

inches] from the foundation, loam, seeding, mulching and all incidentals necessary to complete the work.

The accepted quantity of junction boxes will be paid for at the contract unit price each. Payment for junction boxes shall include furnishing and installing precast concrete or bituminized fiber boxes as designated, including that portion of conduit extending 300 mm [12 inches] outside the box.

Payment will be made for the total number of meters [linear feet] of each type of underground or exposed conduit actually furnished, installed and accepted at the contract price per meter [linear foot]. This price shall include the cost of: furnishing and installing the conduit; excavating; furnishing special backfilling materials, pull wire, fittings, groundings and bonding; test cleaning interiors of conduits and all materials, labor, equipment and incidentals necessary to complete the work.

Excavating and backfilling for junction boxes, foundations and excavating, backfilling and sand bedding for conduit ducts will be considered included in the respective contract unit prices and no separate payment will be made, except as hereafter provided.

Excavating and backfilling as shown on the plans, or as required to overcome soft or otherwise unsuitable material, or for excavating rock will be paid for as provided in Section 206 -- Structural Excavation. Required backfill material, except sand bedding as shown on the detail plan, will be paid for as provided in Section 304 -- Aggregate Base and Subbase Course.

Payment will be made for the total number of meters [linear feet] of prewired conduit actually furnished, installed and accepted at the contract price per meter [linear foot]. This price shall include the cost of hand digging, trenching, or plowing; furnishing and installing the prewired conduit; and all labor, equipment and incidentals necessary to complete the work.

The accepted quantity of ground mounted cabinet foundations will be paid for at the contract unit price each, which payment shall include conduit within the foundation and extending 300 mm [12 inches] from the foundation and for loam, seeding, mulching and all incidentals necessary to complete the work.

Prewired conduit within the foundations and extending 300 mm [12 inches] from the foundation, and prewired conduit within the junction box and extending 300 mm [12 inches] outside the junction box, shall be considered incidental to the respective contract unit prices for light standard foundations and junction boxes and no additional payment will be made.

The accepted quantity of Remove or Modify Concrete Foundations will be paid for at the contract unit price each. Such price shall include disposing of concrete removed, backfilling with granular material, loaming, seeding and all incidentals necessary to complete the work.

Payment for restoration of roadway pavement, sidewalks, grass areas and resetting curbing removed in conjunction with this work, shall be considered incidental to the respective contract prices for each related item, except as otherwise provided.

Payment will be made under:

Pay Item	Pay Unit
626.11 Precast Concrete Junction Box: ____	Each
626.12 Bituminized Fiber Junction Box: ____	Each
626.21 Metallic Conduit	meter [Linear Foot]
626.22 Non-metallic Conduit	meter [Linear Foot]
626.23 Prewired Conduit Secondary Wiring	meter [Linear Foot]
626.24 Prewired Conduit Primary Wiring	meter [Linear Foot]
626.31 450 mm [18 inch] Foundation	Each
626.32 600 mm [24 inch] Foundation	Each
626.33 750 mm [30 inch] Foundation	Each
626.34 Signal Pole Foundation	Each
626.35 Controller Cabinet Foundation	Each
626.36 Remove or Modify Concrete Foundation	Each
626.37 Special Foundation	Each
626.38 Ground Mounted Cabinet Foundation	Each

SECTION 627 -- PAVEMENT MARKINGS

627.01 Description. This work shall consist of furnishing and placing reflectorized pavement lines and markings, removing pavement lines and markings and furnishing and applying reflectorized paint to curbing in reasonably close conformity with the plans and as designated.

MATERIALS

627.02 Materials. Materials shall conform to the requirements specified in the following Subsections of Division 700 -- Materials.

Pavement Marking Paint	708.03
Reflectorized Plastic Pavement Marking	712.05

627.03 Vacant

CONSTRUCTION REQUIREMENTS

627.04 General. All pavement lines and markings shall be applied in accordance with the Manual on Uniform Traffic Control Devices.

Longitudinal lines placed on tangent roadway segments shall be straight and true. Longitudinal lines placed on curves shall be continuous smoothly curved lines consistent with the roadway alignment. All pavement markings placed shall meet the tolerance limits shown on the plans.

Broken lines shall consist of alternate 3 m [10 foot] painted line segments and 9m [30 foot] gaps.

Temporary pavement markings shall be applied in accordance with the pattern shown on the plans or as directed.

Newly painted lines, markings and curb shall be protected from traffic by the use of cones, stationary vehicles or other approved methods until the paint is dry.

627.05 Preparation of Surface. Immediately before applying the pavement marking paint to the pavement or curb, the surface shall be dry and entirely free from dirt, grease, oil or other foreign matter.

Surface preparation for application of plastic markings shall conform to the manufacturer's recommendations.

627.06 Application. Prior to applying paint for final pavement lines, the Contractor shall perform a test for paint thickness by furnishing and placing a piece of smooth, clean metal with an area of at least 0.1 m² [144 square inches] in the path of the striping truck. The striping truck shall be passed over the piece of metal, painting the surface as it passes, without applying beads. The result of this test will be used to determine the pressure setting and speed of the truck when applying paint to obtain the specified thickness. Additional paint thickness testing may be required on the final paint markings. The wet thickness of paint without beads on final pavement lines shall be a minimum of 0.400 mm [16 mils].

On other final pavement markings and on curb, where the paint is applied by hand painting or spraying, application shall be in two uniform covering coats, each at least 0.25 mm [10 mils] thick. Before the second coat of paint has dried, the glass beads shall be applied by a pressure system which will force the glass beads onto the undried paint as uniformly as possible.

Glass beads shall be applied to the final and temporary pavement lines, marking and curb at the rate of 0.54 kg/L [4.5 pounds per gallon] of paint and in sufficient quantity to assure complete and uniform coverage of hand painted surfaces.

Temporary painted lines and markings shall be applied as specified for permanent painted lines, except that the thickness shall be a minimum of 0.400 mm [16 mils].

Temporary pliant polymer marking material shall be used for temporary markings on the final pavement and on pavements not to be resurfaced when such pavement markings do not conform to the final pavement markings pattern.

The plastic final pavement lines and markings shall be applied in accordance with the manufacturer's recommendations by the inlay method of application.

627.07 Establishment Period. Inlaid plastic pavement lines and marking material furnished and installed under this contract for final pavement markings shall still be subject to a six month period of establishment.

The period of establishment shall commence as soon as the plastic pavement lines and markings are complete and in place and shall continue for six months. At the end of the

establishment period, a minimum of 95 percent of the plastic pavement lines and markings shall still be in place to be acceptable.

If less than 95 percent of the plastic pavement lines and markings are in place after six months, the Contractor shall replace all unsatisfactory plastic pavement lines and markings on the project without additional payment. Plastic pavement lines and markings designated for replacement shall be installed according to these specifications, unless otherwise directed. Plastic pavement lines and markings replaced at the end of the six month establishment period will not be subject to a further establishment period.

627.08 Removing Lines and Markings. When it is necessary to remove pavement lines and markings, it shall be done by grinding, high temperature flame, sand blasting, solvent or other acceptable means. The method chosen must be capable of completely eradicating the existing line or marking without damage to the pavement. Burning and grinding to remove temporary markings from final pavement or from existing pavement not to be resurfaced will not be permitted.

627.09 Method of Measurement. Longitudinal lines parallel to the centerline of the roadway will be measured by the meter [linear foot] along the centerline stationing of the roadway. Other lines will be field-measured or computed. The measurement of broken lines will include the gaps when painted and will not include the gaps when plastic. All other pavement markings will be measured by the square meter [square foot].

Reflectorized curb will be measured or computed by the square meter [square foot] of curb surface actually painted and reflectorized.

Removing pavement markings will be measured by the square meter [square foot] of pavement marking.

627.10 Basis of Payment. The accepted quantities of pavement lines, markings and reflectorized curb will be paid for at the contract unit price per meter [linear foot] or square meter [square foot] for the colors, widths or shapes specified, complete in place. No direct payment will be made for performing the paint thickness test, nor for furnishing the metal plate to receive the paint; but the cost of such work shall be incidental to pavement markings.

The accepted quantity of Removing Pavement Markings, including temporary painted pavement marking lines, will be paid for at the contract unit price per square meter [square foot], except that any lines or markings applied by the Contractor which are not within reasonably close conformity to the markings, as laid out by the Engineer, shall be removed without compensation.

Payment for final plastic pavement lines and markings will be made in two parts. The first payment of 75 percent will be made when plastic pavement lines and markings are placed. The payment of the remaining 25 percent will be made at the end of the establishment period for all plastic line and pavement markings accepted.

The accepted quantities of temporary painted pavement marking lines will be paid for at the contract unit price per meter [linear foot] complete in place, of the appropriate color, as directed. Repainting of temporary painted pavement marking lines will be incidental to Item 652.36 and no separate payment will be made.

The accepted quantities of temporary plastic pavement marking lines will be paid for at the contract unit price per meter [linear foot] complete in place, of the appropriate color, as directed. Payment for replacement of temporary plastic pavement marking lines and removal of the plastic material when no longer needed shall be included in Item 652.36 or 652.361 - Maintenance of Traffic Control Devices and no separate payment will be made.

Payment will be made under:

Pay Item	Metric Units	Pay Unit
627.61 100 mm Solid White Pavement Marking Line		meter
627.611 150 mm Solid White Pavement Marking Line		meter
627.62 100 mm Broken White Pavement Marking Line		meter
627.621 150 mm Broken White Pavement Marking Line		meter
627.63 100 mm Solid Yellow Pavement Marking Line		meter
627.631 150 mm Solid Yellow Pavement Marking Line		meter
627.64 100 mm Broken Yellow Pavement Marking Line		meter
627.641 150 mm Broken Yellow Pavement Marking Line		meter
627.65 White or Yellow Pavement and Curb Marking		square meter
627.67 Removing Pavement Markings		square meter
627.68 Temporary 100 mm Painted Pavement Marking Line, White or Yellow		meter
627.681 Temporary 150 mm Painted Pavement Marking Line, Yellow or White		meter
627.69 Temporary 100 mm Plastic Pavement Marking Line, Yellow or White		meter
627.691 Temporary 150 mm Plastic Pavement Marking Line, Yellow or White		meter

Pay Item	English Units	Pay Unit
627.61 4 inch Solid White Pavement Marking Line		Linear Foot
627.611 6 inch Solid White Pavement Marking Line		Linear Foot
627.62 4 inch Broken White Pavement Marking Line		Linear Foot
627.621 6 inch Broken White Pavement Marking Line		Linear Foot
627.63 4 inch Solid Yellow Pavement Marking Line		Linear Foot
627.631 6 inch Solid Yellow Pavement Marking Line		Linear Foot
627.64 4 inch Broken Yellow Pavement Marking Line		Linear Foot
627.641 6 inch Broken Yellow Pavement Marking Line		Linear Foot
627.65 White or Yellow Pavement and Curb Marking		Square Foot
627.67 Removing Pavement Markings		Square Foot
627.68 Temporary 4 inch Painted Pavement Marking Line, White or Yellow		Linear Foot
627.681 Temporary 6 inch Painted Pavement Marking Line, Yellow or White		Linear Foot
627.69 Temporary 4 inch Plastic Pavement Marking Line, Yellow or White		Linear Foot
627.691 Temporary 6 inch Plastic Pavement Marking Line, Yellow or White		Linear Foot

SECTION 628 -- BLASTING

Reserved

SECTION 629 -- HAND LABOR

629.01 Description. This work shall consist of furnishing and supervising workmen when authorized or directed in accordance with these specifications.

CONSTRUCTION REQUIREMENTS

629.02 General. Work under this section shall require no special skill but shall be accomplished in a workmanlike manner. The personnel shall be physically and mentally capable of efficiently performing the assigned duties.

Nothing in this section shall be construed to relieve the Contractor of his responsibility for furnishing personnel under other contract items. The intent is that this item shall be used to perform necessary work not covered or provided for under existing contract items or other sections of the specifications.

629.03 Method of Measurement. Hand labor will be measured by the man hours of work actually performed, measured to the nearest 1/4 hour. Overtime, when authorized, will be computed in compliance with the labor requirements of the contract. The work week shall be defined as starting on Monday and ending on Saturday, inclusive. Each day the Contractor shall supply the names and number of hours each man works under this item.

629.04 Basis of Payment. The accepted quantities of labor will be paid for at the contract unit price per man hour. Payment for overtime will be made in compliance with the labor requirements of the contract.

The contract unit price shall be full compensation for hiring, transporting, supervising, payment of workmen's compensation, social security taxes, unemployment insurance and for all hand tools, protective clothing and all incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
629.05 Hand Labor, Straight Time	Man Hour

SECTION 630 -- TRAFFIC CONTROLLERS

630.01 Description. This work shall consist of furnishing uniformed personnel to control vehicular and pedestrian traffic during construction.

SPECIAL REQUIREMENTS

630.02 General. Traffic controllers working under the requirements of this section shall be individuals specifically trained for controlling traffic. The controllers shall be supplied with an appropriate uniform and wear blaze orange vests.

While controlling traffic, traffic controllers should stand either on the shoulder adjacent to the traffic being controlled or in the barricaded lane. At a spot obstruction, the traffic controller may stand on the shoulder opposite the barricaded sections. The traffic controller should stand alone and be clearly visible to approaching traffic at all times. When not clearly visible to approaching traffic, additional traffic controllers shall be used at the rear of the backlogged traffic.

630.03 Traffic Control. Arrangements to expedite the flow of traffic shall be made by the Contractor and approved.

630.04 Method of Measurement. Traffic Controllers will be measured by the number of man hours necessary and authorized. Premium time will be included for measurement in accordance with the policy of the agency furnishing the controllers and in accordance with the requirements of the Work Hours Act of 1962.

630.05 Basis of Payment. The authorized hours of Traffic Controllers, with or without special equipment, will be paid under the provisions of Subsection 109.04, (g).

When traffic controllers are not available, flaggers may be authorized. Payment for flaggers will be made as provided in Section 652 -- Maintenance of Traffic.

SECTION 631 -- EQUIPMENT RENTAL

631.01 Description. This work shall consist of furnishing and operating construction equipment as called for on the plans and/or specified in the Special Provision.

EQUIPMENT REQUIREMENTS

631.02 General. Equipment used for work under this section shall conform to the following minimum sets of requirements:

Equipment	Description	Minimum Size
Aerator	Heavy duty disc harrow-front and rear axle angle adjustable	Two tandem rows, 710 mm [28 inch] minimum diameter discs with 50 mm [2 inch] allowance for wear, 3 400 kg [7,500 lbs.], 1.5 m [5 foot] width.
Air Compressor	Gasoline or diesel powered unit with compressor, receiver and adequate air hose	2.4 m ³ [85 cubic feet] per minute at 690 kPa [100 pounds per square inch]
Air Tool	Single compressed air driven hand drill, tamper, hammer, chipper or pavement breaker	
All Purpose Excavator	Approved truck mounted type	2.75 Mg [Three tons] capacity lifting class at 4.5 m [15 foot] radius
Heavy Duty Purpose Excavator	Approved Truck mounted type	6.3 Mg [7 tons] capacity lifting All class at 4.5 m [15 foot] radius
Bulldozer	Crawler or pneumatic tired tractor with pushing blade	69 kW [93 horsepower] (flywheel), Weight (tractor) 7900 kg [17,500 lbs.]
Small Bulldozer	Crawler with pushing blade	22 kW [30 horse power]
Chain Saw	Gasoline or electric powered with endless chain type blade	450 mm [18 inch] cutting blade
Culvert Cleaner	Water Jet nozzle, pump and tank	130 L [35 gallons] per minute 8620 kPa [1,250 lbs. per square inch]
Front End Loader	Front end scoop mounted on pneumatic tires	1.5 m ³ [2 cubic yard] rated capacity
Small Front End Loader	Front end scoop mounted on crawler or pneumatic tires	0.17 m ³ [6 cubic foot] minimum rated capacity
Grader	Tandem drive	6350 kg [14,001 lbs.]
Road Broom	Engine driven rotary broom	2.1 m [7 foot] broom
Roller (earth or base	Self-propelled pneumatic tire type	Gross wt. 3700 kg [2,500] pounds per foot] of rolling width. 1 m [40 inch] width.

course)		Tire ground pressure 450 kPa [65 psi]
Roller (pavement)	Self-propelled pneumatic minimum 7 wheels	Gross weight 25 400 kg [56,000 lbs.,] 300 x 600 mm [12 x 24 inch] smooth tread tires capable of 760 kPa [110 psi] inflation pressure; pressure Fully ballasted wheel loads=3600 kg [8,000 lbs.] or more
Rototiller	Rotary cultivator mounted on pneumatic tired tractor	18 kW [25 Horsepower]
Stump Chipper	Gasoline powered stump chipping machine	44 kW [60 Horsepower]
Truck, small	Pneumatic tired with dump body rated capacity	3.8 to 6.1 m ³ [5 to 8 cubic yards], manufacturers
Truck, Over 6.1 m ³ [8 cubic large	Pneumatic tired with dump body capacity	yards] manufacturers rated

CONSTRUCTION REQUIREMENTS

631.03 General. Nothing in this section shall be construed to relieve the Contractor of his responsibility for completing work under other contract items. These items shall be used to perform only such work as is called for on the plans or specified in the Special Provisions to be paid under equipment rental items.

631.04 Aerating. When roadway excavation materials contain excessive moisture which will not permit proper compaction, the Contractor shall, when directed, aerate the materials until a water content suitable for compaction is obtained.

631.05 Grading. All grading shall be done in a manner to leave the area smooth and suitable for machine mowing and to provide proper drainage or as otherwise directed by the Engineer. Suitable excavated material shall be placed and compacted on embankment slopes or other areas as directed. Unsuitable material shall be disposed of in approved waste areas.

631.06 Rolling. All material under this item shall be compacted to the satisfaction of the Engineer. Only those portions of roadway designated for rolling shall be rolled. The work shall be performed under such conditions that maximum compaction can be obtained.

631.07 Method of Measurement. Equipment rental will be measured by the hour to the nearest 1/4 hour. Time spent moving to and from the site within the project limits and from beyond the project limits, servicing, maintaining and changing attachments will not be measured for payment.

Foreman will be measured by the hour to the nearest ¼ hour of time actually spent supervising operators of hourly equipment rental pay items. The name of the supervisor will be supplied to the Engineer.

Supervision required in the performance of hourly equipment rental work will be measured for payment only when the Engineer specifically requests a foreman's presence to direct the operation. This item does not relieve the Contractor of his responsibility to supervise other contract items.

631.08 Basis of Payment. The accepted quantities of equipment rental will be paid for at the contract unit price per hour for each type of equipment used. Payment shall include operators, fuel, grease, oil and other incidentals necessary to operate the equipment. Tractors required to haul aerators will be considered incidental to the contract unit bid price for machine aerating.

No separate payment will be made to direct work done under these items, except when supervisory personnel are specifically requested by the Engineer. Payment will then be made under Item 631.36 Foreman or Subsection 109.04, Extra and Force Account Work.

Payment made will be limited to the grade of foreman and limited to hours spent in actually supervising equipment operators. Such related costs as use of pickup truck, meal and room expenses, benefits, insurance, retirement, travel time, and overtime will not be paid for separately but will be considered incidental to the unit price bid for this pay item.

Payment will be made under:

Pay Item	Pay Unit
631.09 Aerator (including operator and hauler)	Hour
631.10 Air Compressor (including operator)	Hour
631.11 Air Tool (including operator)	Hour
631.12 All Purpose Excavator (including operator)	Hour
631.121 Heavy Duty All Purpose Excavator (including operator)	Hour
631.13 Bulldozer (including operator)	Hour
631.132 Small Bulldozer (including operator)	Hour
631.14 Grader (including operator)	Hour
631.15 Roller, earth and base operator)	Hour
631.16 Roller, Pavement (including operator)	Hour
631.171 Truck-small (including operator)	Hour
631.172 Truck-large (including operator)	Hour
631.18 Chain Saw Rental (including operator)	Hour
631.20 Stump Chipper Rental (including operator)	Hour
631.21 Road Broom (including operators and hauler)	Hour
631.22 Front End Loader (including operator)	Hour
631.221 Small Front End Loader (including operator)	Hour
631.29 Rototiller (including operator)	Hour
631.32 Culvert Cleaner (including operators)	Hour
631.36 Foreman	Hour
631.37 Cleaning Existing Catch Basins and Manholes	Each

SECTION 632 -- VACANT

SECTION 633 -- VACANT

SECTION 634 -- HIGHWAY LIGHTING

634.01 Description. This work shall consist of furnishing and installing a highway lighting system or modifying or removing an existing highway lighting system in accordance with these specifications and in reasonably close conformity with the plans.

MATERIALS

634.02 General. All material furnished by the Contractor shall be new unless otherwise specified. Substitutes for specified material may be accepted, if approved. Substitutes shall provide equal or better service. Where an existing system is to be modified, the existing material shall be removed, upgraded or disposed of as shown on the plans or as directed.

All electrical equipment shall conform to NEMA, UL or EIA the standards, wherever applicable. In addition, all materials and workmanship shall conform to the requirements of the NEC, the local electrical utility and all local ordinances which may apply.

634.021 Materials. Materials shall meet the requirements specified in the following Subsection of Division 700 -- Materials:

Steel Conduit	715.02
Non-metallic Conduit	715.03
Prewired Conduit	715.04
Metallic Junction and Fuse Box	715.05
Secondary Wiring	715.07
Luminaires, Lamps and Ballast	715.08
Luminaires, Lamp and Ballast for High Mast Lighting	715.09
Photo Electric Control	715.10
Service Equipment	715.11
Lowering System for High Mast Lighting	715.12
Astronomical Time Switch	715.13
Aluminum Supports	720.01
Aluminum Mast Arm and Bracket Arm	720.02
Steel Supports	720.03
Steel Mast Arm and Bracket Arm	720.04
High Mast Light Standard	720.05
Steel H-beam Poles	720.06
Anchor Bolts	720.0
Wood Ornamental Light Standard	720.09

Wood Utility Pole	720.10
Mast Arm for Wood Utility Pole	720.11
Breakaway Devices	721.01

Transformer enclosures shall conform to NESC requirements. They shall be approximately 1175 mm [46 inches] high, 1050 mm [42 inches] wide, and 1050 mm [42 inches] deep. Dimensions should be verified with the electrical utility before ordering. Clearances shall be provided as required by the NESC. The enclosure shall be painted inside and outside with one coat of red iron-oxide primer and a finish coat of gray baked enamel. Doors shall be furnished with padlock lugs.

The electric portable power unit shall be a heavy-duty reversing electric motor for the voltage and frequency shown on the plans and shall have a remote control.

The following are the minimum requirements for the high mast lighting lowering system:

Ball bearing motor

Grounded frame

Torque limiter

Power unit mounting frame

Coupling to winch drive shaft

Remote control unit with cable

Cable with twist lock receptacle and plug for operator of power unit

All bolts for mounting lighting fixtures under bridge structures shall conform to the requirements of ASTM A307. These bolts and other fastening hardware shall be hot-dipped galvanized in accordance with ASTM A153.

Screened sand for bedding and covering direct buried cables shall meet the requirements of Subsection 703.14, except that there shall be 0-10 percent passing the 75 m [No. 200 sieve].

634.022 Equipment List and Drawings. Unless otherwise permitted in writing, the Contractor shall submit for review a list of equipment and materials which he proposes to furnish. The list shall include the name of manufacturer, size and identifying number of each item and other necessary data, including detailed scale drawings, wiring diagrams of special equipment and any proposed minor deviations from the plans. If requested, the Contractor shall submit sample articles of the material proposed for use. All of the above data except sample articles, shall be submitted in duplicate. Following checking, correction and approval, not less than two complete sets of approved drawings shall be submitted. The Department will not be liable for material purchased, labor performed or work delayed prior to such review. Where electrical equipment is to be constructed as shown on the plans, the submission of detailed drawings and diagrams will not be required.

Upon completion of the work, the Contractor shall submit three complete sets of corrected plans showing all construction changes.

634.023 Miscellaneous Material. Insulating tape shall be of the self-bonding type. Jacket tape shall be of the water- resisting type. Friction tape shall be rubber-impregnated, woven cotton fabric.

634.024 Light Standards. The terms "conventional standard" or "conventional light standard" shall mean the assembled metal base flange, transformer base or breakaway device, metal columnar shaft, metal overhanging bracket arm and incidental hardware.

The design, materials and fabrication of structural supports for luminaires shall meet the requirements of the current edition of AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals" and interims thereto, except as otherwise indicated within these specifications or on the contract plans. Light standards with a luminaire mounting height in excess of 15 m [50 feet] shall be designed using wind speeds based on a 50-year mean recurrence interval; and light standards with a luminaire mounting height of 15 m [50 feet] or less shall be designed using wind speeds based on a 25-year mean recurrence interval. For luminaire supports mounted on structures and approaches to structures, the mounting height shall be measured as follows:

- (a) For bridges over bodies of water: above the prevailing water level or, in the case of tidal waters, above mean high tide.
- (b) For overpass structures: above the lower roadway level.
- (c) For approach ramps: above the average adjacent ground level, if said ground level is more than 3 meters [10 feet] below the base of the light standard.

The design weight of luminaires shall be 27 kg [60 pounds] with an effective projected area of 0.2 m² [2.5 square feet], except that poletop-mounted luminaires shall have an effective projected area of 0.45 m² [5.0 square feet].

Deflections of light standards and bracket arms shall be limited as follows:

- (d) Light standards shall be able to support a 225 kg [500 pound] transverse load, applied at 450 mm [18 inches] below the pole top with a maximum deflection of 5 percent of the nominal pole length.
- (e) Bracket arms shall be able to support a horizontal load of 23 kg [50 pounds] and a concurrent vertical load of 45 kg [100 pounds], applied at the luminaire tenon, without developing a measurable permanent set.
- (f) High mast light standards shall have a maximum deflection of 7 percent of the nominal pole length under full design load when equipped with four luminaires.

Conformance to the above deflection criteria for high mast light standards may be substantiated by actual tests on materials produced for delivery under a Maine Department of Transportation contract or by detailed computations.

Fluted aluminum breakaway couplings shall be supplied for use at all locations designated as breakaway unless the anchor bolt dimensions or other conditions prevent the use of such

breakaway couplings. If fluted aluminum breakaway couplings cannot be used, aluminum light standards with breakaway transformer bases or steel light standards with slip bases shall be used as an alternate. Fluted aluminum breakaway couplings shall not be used in conjunction with transformer bases.

After execution of the contract and before any shop work is commenced, the Contractor shall submit three sets of the manufacturer's drawings of all standards and accessories proposed to be furnished and erected under this contract. The drawings shall be of sufficient detail to indicate material and dimensional conformance with these specifications and the contract drawings. Each drawing shall contain a reference to the design criteria and a certification that the design criteria have been met for the light standards, bracket arms and associated hardware, fittings and breakaway devices, as submitted. The certification shall be signed by a Registered Professional Engineer under his official seal. The drawings shall use the same units found in the project plans.

It is the intent of these specifications that the Contractor shall be fully responsible for the adequacy of the sizes, wall thicknesses, materials and connections of the standards, bracket arms and associated hardware, fittings and breakaway devices. Approval of the drawings will signify only approval of the material(s), mounting height(s) and bracket arm length(s).

For high mast lighting standards, the Contractor shall submit, in addition to the manufacturer's drawings, three copies of the design computations. Approval of the drawings and computations will signify approval of all structurally significant details of the light standard and the luminaire mounting and lowering device.

Approval for deviations from the contract drawings and/or specifications shall be requested in writing and shall be approved before being incorporated in the manufacturer's drawings.

A Certificate of Compliance shall be provided for all material in accordance with the requirements of the General Statement of Division 700 -- Materials.

Light standards and anchor bolts shall meet the requirements specified in Section 720 -- Structural Supports for Highway Signs, Luminaires and Traffic Signals.

All welding shall conform to the applicable provisions of the latest edition of the AWS Structural Welding Code, Steel, D1.1 for steel construction, or the latest edition of the AWS Structural Welding Code, Aluminum D1.2 for aluminum construction.

CONSTRUCTION REQUIREMENTS

634.03 General. The location of the roadway lighting systems and other incidental work will be shown on the plans. They are diagrammatic only, but shall be followed as closely as actual conditions at the site and the work of other Contractors will permit. As the work progresses, the drawings may be revised or supplemented by the Engineer, and the Contractor shall perform the work required by such revisions or supplements without additional compensation, except as provided in Subsection 104.02.

Work shall be scheduled to assure that each highway lighting system shall be completed and ready for operation upon completion of the corresponding section of the roadway or as specified in Section 108 -- Prosecution and Progress.

Before proceeding with any work under this Contract, the Contractor shall conduct continuity and insulating tests to establish the integrity of cable runs already in place. The Contractor shall report all cable faults to the Engineer. In cases faults are located while contract work is in progress and the Contractor does not report them, the Contractor will be responsible for correcting those faults without extra compensation.

634.04 Cable Installation. The Contractor shall pull all wires through conduits without overstressing or stretching any wire or scoring, cutting, twisting or damaging the protective covering or insulation. When pulling cable into conduits, if the strain on the cables is likely to prove excessive, the Contractor shall use soapstone powder as a lubricant. Where two or more cables are to occupy the same conduit, they shall be drawn in together and kept parallel to each other by the use of a pulling head.

Both ends of each length of cable shall be sealed to prevent the entrance of moisture during shipment or during outdoor storage. Defective and damaged cable will be rejected and shall be replaced at no cost to the State.

Secondary wiring shall be installed as shown on the plans. Secondary wiring shall not be spliced except in junction boxes, hand holes in poles, transformer bases or locations shown on the plans. The wire for secondary circuits which is pulled through ducts shall be fed slack from the feed end.

Cables in junction boxes shall be provided with adequate slack for splicing and shall be arranged as directed. After cables have been installed and before permanent splicing, the end of each section of cable in light standards, junction boxes and panel boxes shall be carefully sealed, using rubber tape, and painted with a sealing-type of waterproof compound. All wiring shall be finished to provide a neat and orderly appearance. Ends of cable not connected to any device shall be insulated and sealed.

The trench for direct-buried cable shall be excavated to the width and depth shown on the plans or as directed.

Placement of the sand bedding shall be coordinated with the installation of the cables. After the cables and screened sand have been placed, the remainder of the trench shall be promptly backfilled with selected excavated material. Surplus material shall be disposed of as directed and

the surface of the trench shall be loamed and seeded in accordance with Section 618 -- Seeding Method Number 1.

When connecting sockets, outlets and other similar equipment, the most accessible bare parts of each piece of equipment shall be connected to the grounded neutral. In order to ensure this has been done, each piece of equipment shall be tested after installation, under the supervision of the Engineer, with a test lamp or other instrument, one leg of which has been connected to a definite ground, or by other approved means of testing.

All cables in junction boxes and light standards shall be tested for circuit connections which shall be in conformity with those indicated on the plans. After verification of circuit connections, all cables in junction boxes, light standards and service panels shall be provided with individual metal tags, die-stamped with a phase designated A or B, as applicable. The tags shall be securely attached to the cables.

Splices to form continuous circuits shall be made by the Contractor and will only be permitted in accessible locations. All splices in underground junction boxes shall be made with cast epoxy splice kits to provide a waterproof splice. All other splices shall be made with approved crimp-type connectors.

Conductors shall not be pulled into conduit until pull boxes are set to grade, crushed rock sumps installed, grout placed around the conduit, concrete bottom of pull boxes placed and the metallic conduit bonded.

Where roadways are to remain open to traffic and existing lighting systems are to be modified, the existing lighting system shall remain in operation and the final connection to the modified circuit shall be made so that the modified circuit will be in operation by nightfall of the same day.

634.05 Light Standard. To provide continuously aligned lamp post installations, light standards shall be located in accordance with the details governing the spacings and set backs shown on the plans, unless otherwise directed.

The bracket arms shall be set normal to the edge of the roadway, unless otherwise directed. The bracket shall be assembled and attached to the shaft before the light standard is erected. If it is anticipated there will be a period in excess of 24 hours between the erection of the light standards and the installation of the luminaires, the Contractor shall install a weight, weighing between 23 to 34 kg [50 to 75 pounds], at the outboard end of each bracket arm. This weight shall be designed and fastened in such a way that it will not pose a hazard to persons passing beneath it.

Light standards shall be erected in a vertical position, with a maximum deviation from the vertical of 6 mm [1/4 inch] in 1500 mm [5 feet], using either the leveling nuts provided with the anchor bolts or the breakaway couplings. Once the light standard is in its final position, the top nuts shall be tightened as follows:

- (a) Anchor bolts with breakaway couplings: The manufacturer's recommendation shall be used.

- (b) Anchor bolts without breakaway couplings: the nut shall be tightened to snug tight condition by utilizing the full effort of a worker using a standard spud wrench or comparable tool. After all nuts have been brought to a snug tight condition, each nut shall be tightened an additional one-third turn using an impact wrench, torque wrench or large crescent wrench.

A minimum of two bolt threads shall project beyond the outside face of the nut.

Nuts for bolts other than anchor bolts shall be tightened as outlined under (b), above, for anchor bolts.

The bottom of all transformer bases shall be coated with a bitumen-mastic, epoxy paint.

When foundations and anchor bolts for light standards have been installed by others, the Contractor shall verify the anchor bolt dimensions at each location so that bases will be furnished with the proper bolt holes.

Wires in the shaft shall be supported with a Kellum-type, braided, strain-relief grip attached to a "J" hook mounted inside the shaft near the top.

Wood Ornamental Light Standards shall be installed as shown on the plans.

634.051 Removing Light Standards. Before removing light standards, the luminaires shall be removed from the light standards and disposed of as noted on the plans.

Care shall be exercised in removing and transporting the light standards. The Contractor will be required to replace, at his expense, all equipment damaged or destroyed by his operations.

634.052 Portable Power Unit for Lowering Luminaires. The number of portable electric power units with remote control required on this project for operation of the high mast luminaire lowering system, will be one for every 10 high mast poles, or as shown on the plans.

634.06 Luminaires. Luminaires shall not be installed until the lamp socket position has been inspected and approved for conformance with the manufacturer's recommended position for the specified distribution. All luminaires shall be adjusted to produce the maximum illumination on the roadway surface.

The connections between the luminaires and connector kits shall be made with single conductor, number 12 wires AWG copper stranded THHN, minimum size. A 355 mm [14 inch] long teflon sleeve shall be placed over each end of each conductor in the luminaire.

Installation of a connector kit, fused or non-fused, shall be in accordance with the manufacturer's instructions to provide completely watertight connections.

634.061 Under-Bridge Lighting. Under-bridge lighting shall be installed in accordance with the plans and specifications, or as directed.

Circuits shall be fused in fuse boxes with 5-ampere cartridge-type, midget fuses, 9.5 mm [12/32 inch] diameter and 38 mm [1½ inches] long, unless otherwise indicated on the plans. Wiring connections in the under-bridge lighting units shall be made with 150 °C [300 °F] wire.

All under bridge lighting luminaires shall be installed and adjusted for maximum illumination of the roadway surface. The beam angle shall be adjusted as indicated on the plans.

In vehicular undercrossings, underpass lights shall be placed in operation as soon as practicable after falsework has been removed from the structure. Lighting for pedestrian structures shall be placed in operation prior to opening the structure to pedestrian traffic.

634.07 Vacant

634.08 Service. The Contractor shall install metal conduit riser with entrance cap, entrance switch, multiple control relay and other equipment as shown on the plans.

The lighting system will be supplied with electrical power by the local power company. The type of service will be single phase, three wire, 240/480 volt or the voltage indicated on the plans, 60 hertz, alternating current. The power company will make all connections of the roadway lighting system cables at the power company's service pole. The Contractor shall notify the power company at least two weeks in advance of the time he intends to start construction at each of the sites and shall make all necessary arrangements with the power company for the required installation.

Roadway lighting cabinets shall be installed on stub poles with doors accessible from the roadway. All connections to equipment and terminals shall be neat and orderly conforming to the requirements specified.

Details for the fabrication and installation of service poles with cabinets and other equipment are shown on the plans.

Transformer enclosures used to protect overhead type transformers mounted on concrete pads shall be installed as shown on the plans. Transformers will be furnished by the power company.

634.081 Bonding and Grounding. All metal conduit ends, light standards, luminaires, control cabinets and exposed noncurrent carrying metal parts of fixed equipment shall be connected to the grounding conductor. All grounding and bonding shall conform to the current provisions of the NEC.

634.09 Testing. Prior to acceptance of the work and in the presence of the Engineer, the Contractor shall cause the following tests to be made on all lighting circuits.

- (a) Continuity. Each circuit shall be tested for continuity.
- (b) Ground. Each circuit shall be tested for grounds.

- (c) Resistance. The resistance to ground on non-ground conductors shall be at least five megaohm at 15°C [60°F] measured with a 1,000 volt megger. The ground resistance shall not be more than 25 ohms.
- (d) Voltage. Voltage readings shall be made at each service pole, in the load contractor, with load and without load, and at each fixture with load.
- (e) Current. Current readings shall be made on the load side of each load contractor phase and neutral. Readings shall be made at night with lighting systems in normal operation.
- (f) Test Data. Electrical test data obtained from the above tests shall be furnished in writing.
- (g) The Contractor shall conduct an operational test for the completed installation under normal operating conditions. This operational test shall have a duration of not less than two full days. The Engineer shall be the sole authority to judge the adequacy of the length of the testing period in order to assure the satisfactory operation of the entire system or any of its sections. The work will not be accepted until the operational test has been successfully completed.
- (h) With all equipment connected to the wiring system, a functional test shall be performed by the Contractor, in the presence of the Engineer, to demonstrate that the system and all parts thereof function as specified. All defective materials or faulty installations shall be corrected by repairs or replacements by the Contractor to the satisfaction of the Engineer at no additional cost.

Lighting circuits shall be subjected to such other tests as may be required and it shall be the responsibility of the Contractor to ascertain what tests are required and to perform these tests in the presence of the Engineer. All tests shall be performed at the expense of the Contractor. Cost for power to conduct tests shall be paid by the Contractor.

634.091 Acceptance. All systems shall be complete and in operation to the satisfaction of the Engineer at the time of acceptance of the work.

The Contractor shall be responsible for the proper performance in service, in whole or in part, of the various lighting systems and all other electrical installations furnished and installed under this Contract and shall correct, at his own expense, all deficiencies in the operation which may arise prior to acceptance of the work. He shall be responsible for the cost of power until the work is accepted.

634.092 Method of Measurement. Highway lighting system will be measured by the lump sum.

Light standards will be measured by the single unit, complete in place and accepted.

The quantity of luminaires for high mast lighting will be measured by each single unit.

634.093 Basis of Payment. The accepted quantity of light standards will be paid for at the contract unit price each for the number of units of the respective types. Payment shall be full compensation for the light standard and breakaway transformer base or breakaway device, bracket arm and all incidentals necessary to complete the work.

Payment for furnishing and installing luminaires for high mast lighting will be made for the accepted quantity at the contract unit price each, which shall include luminaire, ballast, lamp and incidentals necessary to complete the work.

The accepted highway lighting system will be paid for at the contract lump sum price for the complete lighting system shown on the plans, except that luminaires for high mast lighting and light standards will be paid for at the contract unit price each.

Lump sum payment for highway lighting system shall be full compensation for furnishing, installing and erecting: ballast, lamps, wiring in underground conduit, pole wiring and all other wiring (except prewired conduit), transformer enclosures, luminaires (except luminaires for high mast lighting), all identification tags, and all materials, labor, equipment, tools, miscellaneous hardware and incidentals necessary to complete the work. Payment shall also include removing and resetting light standards, installing breakaway devices on existing poles, disposing of unused light standards, as noted on the plans, and for furnishing portable electric power units.

No separate payment will be made for bonding, grounding and ground rods; these costs shall be included in the contract price for conduit, light standards, service panels, or other items requiring bonding and grounding.

Trenching for direct buried cable will be incidental to highway lighting system and shall include excavating, furnishing and placing screened sand and backfilling.

Payment will be made under:

Pay Item	Pay Unit
634.160 Highway Lighting	Lump Sum
634.164 Luminaires for High Mast Lighting	Each
634.206 Light Standard for Post Top Luminaire	Each
634.207 High Mast Light Standard	Each
634.209 Wood Ornamental Light Standard	Each
634.210 Conventional Light Standard	Each

SECTION 635 -- PREFABRICATED BIN TYPE RETAINING WALL

635.01 Description. This work shall consist of the construction of bin type retaining wall in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established.

MATERIALS

635.02 Materials. Materials shall meet the requirements specified in the following Subsection of Division 700 -- Materials:

Gravel Borrow	703.20
Precast Concrete Units	712.06
Metal Bin Type Retaining Wall	713.07

Bedding and backfill material shall be gravel borrow.

CONSTRUCTION REQUIREMENTS

635.03 Shop Drawings. The Contractor shall prepare shop detail erection and other working plans and shall submit two copies for approval. Approval of the plans shall be obtained before fabrication of the work is commenced. Changes in the approved plans shall be subjected to further approval and the Engineer shall be supplied with a record of such changes. The drawings shall use the same units found in the project plans.

The Contractor will be responsible for the correctness of his plans even though plans have been approved.

635.04 Excavation and Foundation. Excavation for erection of the retaining wall shall be in accordance with Section 203 -- Excavation and Embankment, to a width sufficient to allow the proper erection of the wall.

The foundation under the entire area of the wall shall be firm. The bedding and backfill material shall be thoroughly compacted. If ledge rock is encountered, a gravel foundation of at least 300 mm [12 inches] in thickness shall be provided.

635.05 Erection. The retaining wall members shall be erected in accordance with the manufacturer's instructions and as shown on the plans. Members shall be handled carefully and all members which are damaged shall be replaced at the Contractor's expense. All bolts for metal walls shall be placed so that heads will be exposed and the nuts tightened on the inside.

635.06 Backfill. The backfilling of the interior of the wall and behind the wall shall progress simultaneously. The material shall be placed in layers not over 200 mm [8 inches] in depth, loose measure and thoroughly compacted by mechanical or vibratory compactors. Puddling for compaction will not be allowed.

635.07 Method of Measurement. Bin type retaining wall will be measured by the square meter [square foot] of front surface not to exceed the dimensions shown on the plans or authorized. The area of each panel shall be determined by multiplying the width of each panel, center to center distance of the columns, by the total height of the panel.

635.08 Basis of Payment. The accepted quantity of bin type retaining wall will be paid for at the contract unit price per square meter [square foot] complete in place.

Excavating beyond the face of the wall, including excavating for bedding and backfill, and furnishing and placing bedding, and backfill material itself will be considered incidental to the contract items and no separate payment will be made.

Payment will be made under:

Pay Item	Pay Unit
635.10 Concrete Bin Type Retaining Wall, Closed Face	square meter [Square Foot]
635.11 Concrete Bin Type Retaining Wall, Open Face	square meter [Square Foot]
635.12 Galvanized Metal Bin Type Retaining Wall	square meter [Square Foot]
635.13 Galvanized Metal Bin Type Retaining Wall with Fiber Coating	square meter [Square Foot]

SECTION 636 -- REINFORCED SOIL WALL

Reserved

SECTION 637 -- DUST CONTROL

637.01 Description. This work shall consist of furnishing and applying water or calcium chloride on the roadway or haul roads for dust control as directed. When no items for dust control are included in the contract, such work will be considered incidental to the contract.

MATERIALS

637.02 General. The water shall not be salt or brackish and shall be free from oil, acid and injurious alkali or vegetable matter.

The calcium chloride shall conform to Subsection 712.02 except that the requirements for total alkali chloride and impurities shall not apply.

CONSTRUCTION REQUIREMENTS

637.03 Sprinkling. Water shall be applied by approved methods and with equipment including a tank with a pressure pump and a nozzle-equipped spray bar.

637.04 Calcium Chloride. Calcium chloride shall be used when authorized for controlling dust on the roadway under construction and on approved haul roads from the pits to the project or in the vicinity of dwellings and where dust constitutes a hazard to traffic. Calcium chloride shall be applied by mechanical spreaders or by hand at the rate designated.

637.05 Method of Measurement. Water for sprinkling will be measured by the cubic meter [unit of 1,000 gallons (MG)] in calibrated tanks or distributors or by accurate water meters.

Calcium chloride will be measured for payment by the number of megagrams [tons] satisfactorily applied.

Delivery slips as specified in Subsection 109.01 will be required except that weight for calcium chloride shall be determined from the weight stated on each bag and the number of bags used.

637.06 Basis of Payment. Water for sprinkling will be paid for at the contract unit price per cubic meter [MG].

Calcium chloride will be paid for at the contract unit price per megagram [ton].

Payment will be made under:

Pay Item	Pay Unit
637.07 Sprinkling	cubic meter [MG]
637.08 Calcium Chloride	megagram [Ton]

SECTION 638 -- BRIDGE LIGHTING

Reserved

SECTION 639 -- ENGINEERING FACILITIES

639.01 Description. This work shall consist of providing, erecting, lighting, equipping and maintaining buildings to be used by the Engineer as field offices or testing laboratories. Upon completion of the work, the buildings and equipment shall remain the property of the Contractor.

MATERIALS

639.02 Materials. Materials for buildings shall be of good quality customarily used in standard frame house or mobile home construction.

CONSTRUCTION REQUIREMENTS

639.03 General. The building of the type called for shall be provided when work is started and shall remain until work is completed unless earlier removal is authorized. The location shall be approved.

A fire extinguisher shall be provided in each building for electrical and chemical fires and effective on all solvents used in the building.

Walls, roof, floor, windows and doors shall be tightly constructed to the required area.

Furnishings shall be supplied as called for. Doors shall be equipped with locks and all keys shall be in the possession of the Engineer. Windows shall be equipped with latches so they may be locked on the inside. Window screens and screen doors shall be supplied when necessary.

639.04 Field Offices. Field offices are designated Type A or Type B. Other offices or buildings, including trailers, may be provided if they substantially equal or exceed the following requirements. During the months of June, July, August and September air conditioning shall be provided in all field offices.

The walls, roof and floor of the building shall be completely insulated with a minimum of 50 mm [2 inches] of insulation. The interior walls shall be covered with suitable wall panelling. The outside walls of the building shall be matched boards, clapboards or other type of siding which shall be painted.

Testing facilities furnished under this section shall include all facilities for testing as described and shall be available for the exclusive use by the Engineer for the duration of the project.

Other types of buildings and facilities may be furnished of equal or better quality.

A public work area will be provided in the field office that shall be designed and constructed so that individuals with disabilities can approach, enter and exit this area.

At least one accessible route to the field office shall be provided from accessible parking. The accessible route shall comply with the Americans with Disabilities Act Accessibility Guidelines (ADAAG) and this specification.

The minimum clear width of an accessible route shall be 915 mm [36 inches] except at doors. The least possible slope shall be used for an accessible route. An accessible route with a running slope greater than 1:20 shall be considered a ramp. Maximum ramp slope is 1:12. The maximum rise for any run of a ramp shall be 30 inches and the minimum clear width shall be 915 mm [36 inches]. Nowhere shall the cross slope of an accessible route exceed 1:50. Changes in level up to 6 mm [1/4 inch] may be vertical and without edge treatment. Changes in level between 6 mm [1/4 inch] and 13 mm [1/2 inch] shall be beveled with a slope no greater than 1:2.

Ground floor surfaces along accessible routes and in accessible rooms and spaces including floors, walks, ramps, stairs, and curb ramps, shall be stable, firm, and slip-resistant.

The main door to the public work area shall have a minimum clear opening of 310 mm [32 inches] with the door opened 90 degrees, measured between the face of door and the opposite stop.

Minimum maneuvering clearances at doors shall be provided. The floor or ground area within the required clearances shall be level and clear.

The handle and other operating devices on accessible doors shall have a shape that is easy to grasp with one hand and does not require tight grasping. Lever-operated mechanisms, push type mechanisms, and U-shaped handles are acceptable designs. Hardware required for accessible door passage shall be mounted no higher than 1220 mm [48 inches] above finished floor.

When parking space is designated, then all related requirements will conform to the following. One accessible parking space shall be located on the shortest accessible route of travel from adjacent parking to an accessible entrance.

The least possible slope shall be used for any ramp. The maximum slope of a ramp shall be 1:12. The maximum rise for any run shall be 760 mm [30 inches] with a minimum clear width of 915 mm [36 inches]. Ramp floor surfaces shall be stable, firm, and slip-resistant.

Level landings shall be provided at bottom and top of each run. The landing shall be at least as wide as the ramp run leading to it with a minimum length of 1525 mm [60 inches].

If a ramp run has a rise greater than 150 mm [6 inches] or a horizontal projection greater than 1830 [72 inches], then it shall have handrails on both sides. Handrails shall have the following features:

- (1) Handrails shall be provided along both sides of ramp segments. The inside handrail on switchback ramps shall always be continuous.
- (2) If handrails are not continuous, they shall extend at least 300 mm [12 inches] beyond the top and bottom of the ramp segment and shall be parallel with the floor or ground surface.
- (3) The clear space between the handrail and the wall shall be 40 mm [1½ inches].
- (4) Gripping surfaces shall be continuous.
- (5) Top of handrail gripping surfaces shall be mounted between 860 [34 inches] and 965 mm [38 inches] above ramp surfaces.
- (6) Ends of handrails shall be either rounded or returned smoothly to floor, wall, or post.
- (7) Handrails shall not rotate within their fittings.
- (8) The diameter or width of the gripping surfaces of a handrail shall be 32 mm to 40 mm [1¼ inches to 1½ inches], or the shape shall provide an equivalent gripping surface.

Firm and sturdy steps shall also be provided with 180 mm [7 inch] maximum riser and 280 mm [11 inch] minimum depth, and at least one handrail extending from the top of the steps to a minimum 305 mm [12 inches] beyond the bottom of the steps.

The Contractor will make reasonable effort(s) to provide wheelchair accessible toilet facilities when "portable" facilities are provided.

The Contractor shall provide wheelchair accessible toilet facilities when flush type facilities, that is, those with running water, are provided; and the Contractor shall provide wheelchair accessible portable facilities, if used, when the contract duration exceeds two continuous construction seasons.

In addition to the facilities previously specified in this subsection, each type field office shall meet the following minimum requirements:

<u>Description</u> - Metric Units	<u>Field Office</u>	
	<u>Type A</u>	<u>Type B</u>
Floor Area-square meter	17	12
Inside Wall Height-millimeter	2134	2134
Window Area-square meters	4.2	3.3
Drafting Table Surface		
Area-square meters	3	3
Drafting Stools-each	3	2
Office Desks-each	1	1
Straight-back chairs-each	2	2
Benches-each	1	1
Lighting Units-each	2	2
Electric Wall Outlets-each	2	2
Wall Closets-each	1	1
Plan Rack for minimum of 6 sets of plans	1	1
Toilet Facility	1	1

<u>Description</u> - English Units	<u>Field Office</u>	
	<u>Type A</u>	<u>Type B</u>
Floor Area-square feet	187	125
Inside Wall Height feet	7	7
Window Area-square feet	45	35
Drafting Table Surface		
Area-square feet	32	35
Drafting Stools-each	3	2
Office Desks-each	1	1
Straight-back chairs-each	2	2
Benches-each	1	1
Lighting Units-each	2	2
Electric Wall Outlets-each	2	2
Wall Closets-each	1	1
Plan Rack for minimum of 6 sets of plans	1	1
Toilet Facility	1	1

All windows shall be provided with shades or blinds.

One hundred ten volt, 60 cycle, continuous electric service shall be supplied for lighting and 15 amp duplex wall outlets. Lighting shall consist of florescent light units with rapid start bulbs located over the work areas for a minimum of 538 lx [50 foot candles] overall.

Drafting surfaces shall be 1000 mm [3 feet 4 inches] above the floor and have shelves beneath. Shelves for plans and rolls shall also be furnished overhead. Drafting stools shall be approximately 700 mm [28 inches] high. Benches shall be 300 x 600 mm by 450 mm high [12 x 24 inches by 18 inches high].

Desks shall be single or double pedestal standard office type.

Field offices shall be furnished with one four drawer letter size metal filing cabinet.

Wall closets shall be 525 mm [21 inches] wide, 375 mm [15 inches] deep and at least 1200 mm [4 feet] high.

Each office shall be furnished with a broom and with cleaning material for cleaning glass.

639.05 Testing Facilities-Soils. The building and facilities shall:

- (a) The building shall be the minimum size and quality as Field Office Type B and placed in an approved location in the vicinity of the project.
- (b) Have adequate heat and ventilation. The method of heating shall be such that a minimum temperature of 18°C [65°F] can be maintained at all times. During the months of June, July, August and September air conditioning shall be provided.
- (c) Be equipped with a gravity or pressure water system with at least 380 L [100 gallon] capacity. The tank shall be piped to a gooseneck faucet at an approved sink within the laboratory. The sink shall have approved outside drainage.
- (d) Have a bench, 1500 mm long by 600 mm wide, 900 mm [5 feet long by 2 feet wide, 3 feet] above the floor, suitable for supporting a sieve shaker and electric hot plate.
- (e) Have a desk with chair or writing table 1200 x 750 mm [4 feet by 2.5 feet], 750 mm [30 inches] above the floor with adequate filing cabinet.
- (f) Have two electric wall outlets; one to be at least 20 amp. Triplex located near the bench described in (d) above.
- (g) Have 1 stool, 700 mm [28 inches] high.
- (h) Have a rack suitable for holding a 200 L [55 gallon] drum of alcohol located outside.
- (i) Be equipped with the following test equipment and supplies. All equipment and supplies shall be in conformance with revisions of AASHTO T11, AASHTO T27 and AASHTO T191. The Maine Department of Transportation Independent

Assurance Sampling and Testing program will be conducted to monitor the precision and accuracy of acceptance tests. All testing equipment shall be of commercial quality and acceptable to the Engineer and all equipment determined to be substandard by this testing program shall be replaced. The Contractor shall install and maintain the equipment in good condition at all times.

1. Coarse series shaker: Mechanical shaker having trays with a minimum of 129 000 mm² [200 square inches] of surface area or; a manually operated shaker box manufactured to close conformity of the plans available at the MDOT Technical Services Division. Woven wire sieves conforming to the requirements of AASHTO M92. Sieve sizes 75 mm [3 inch], 25 mm [1 inch], 19 mm [3/4 inch], 12.5 mm [1/2 inch] shall be provided for each type of shaker used.
2. Motorized Sieve Shaker with timer, either a combination rocking and tapping action, or rheostat controlled vibrating type. The shaker shall be capable of holding a nest of six 200 mm [8 inch] full height sieves and pan.
3. Set of U.S. Standard Brass or Stainless Steel 200 mm [8 inch] diameter woven wire sieves conforming to the requirements of AASHTO M92 and the sieves required shall include the following sizes:

Metric	English
25 mm	1 inch
two 19 mm	two 3/4 inch
12.5 mm	1/2 inch
9.5 mm	3/8 inch
6.3 mm	1/4 inch
4.75 mm	No. 4
2.36 mm	No. 8
2.0 mm	No. 10
two 1.18 mm	two No. 16
850 m	No. 20
600 m	No. 30
425 m	No. 40
300 m	No. 50
150 m	No. 100
two 75 m	two No. 200
pan and cover	

4. Balance: Electric digital 2,000 gram minimum capacity, sensitive to 0.1 gram and conforming to AASHTO M231 Class G-2.
5. Balance: at least 34 kg [75 pounds] capacity sensitive to 0.02 kg [0.05 pounds] confirming to AASHTO M231 Class G100.

6. Balance: at least 11 kg [25 pounds] capacity sensitive to 0.005 kg [0.01 pounds] conforming to AASHTO M231 Class G20 and must be easily portable.
7. Density Apparatus: a 150 mm [6 inch] sand cone, four 3.785 L [one gallon] glass or 2 plastic jugs with standard "G" mason jar tops and base plate conforming to the requirements of AASHTO T191.
8. Density box to store and protect the density equipment, manufactured to reasonably close conformity of the plans available at the MDOT Technical Services Division.

The box shall be the size to hold the equipment chosen by the Contractor.

9. Two (2) hot plates, each with two burners 700 to 800 Watt, 3 prong grounded plug, with adjustable control for each burner.
10. Six Drying Pans: 250 x 375 x 50 mm [10x15x2 inch] deep heavy gauge aluminum.
11. Safety Can: An OSHA approved 9.5 L [2½ gallon] safety can equipped with a spring loaded closure and pressure relief devices for transporting alcohol.
12. Heat Resistant Gloves: Long cuff leather welding gloves.
13. Two D-Handle square end shovels - 240 mm [9½ inches] wide.
14. One long handle spade.
15. Two 1.5 x 1.5 m [5x5 foot] imperious vinyl coated nylon canvas for quartering samples.
16. One sample splitter - a stainless steel splitter, conforming to AASHTO T248 paragraph 6.1, with curled safety edges.
17. Miscellaneous small tool and equipment: one 0.45 kg [16 ounce] steel hammer; one screwdriver 300 mm [12 inches] long with a 10 mm [3/8 inch] shaft; two 38 mm [1½ inch] paint brushes; three 375 mm [15 inch] heavy gauge stainless steel spoons; one brass bristle sieve brush; one 2 m [6 foot] folding rule; one 500 ml. squeeze bottle; one wash bottle (a 3.785 L [one gallon] wide mouth plastic bottle or a 150 x 300 mm [6 inch x 12 inch] plastic concrete cylinder mold); one floor broom.
18. A ten person general purpose first aid kit.

639.06 Testing Facilities - Bituminous Mixes. The building and facilities shall:

- (a) Be a building the same minimum size and quality as Field Office, Type A, placed in an approved location at the mixing plant. Doors, windows and air conditioning shall meet the requirements of Subsections 639.03 and 639.04.
- (b) Have two benches, 1.5 m [5 feet] long, 750 mm [30 inches] wide, 900 mm [3 feet] above the floor, suitable for supporting equipment with 1 stool, 700 mm [28 inches] high.
- (c) Have 5 duplex electric outlets with ground, 4 outlets to be at least of 20 amp capacity each on separate circuits, placed 2 at each bench described in (b) above. The total service shall have a capacity of at least 100 amperes at 120 volts.
- (d) Have a desk with desk chair, or a writing table 1200 mm [4 feet] by 750 mm [2.5 feet], 750 mm [30 inches] above the floor, with an adequate filing cabinet.
- (e) Have a hooded booth area with an exhaust system. The hood shall be 1800 mm [6 feet] long by the depth of the work bench located a minimum of 750 mm [2½ feet] above the work surface and enclosed on 3 sides. The hood shall be constructed of 1.52 mm [16 gauge] sheet metal with all edges turned. The hood and ventilation system shall have an effective working opening on the front side of 1800 x 750 mm [6 by 2½ feet] high and constructed such that make-up air will be drawn from behind the worker through the hood. The exhaust duct to the outside of building shall not allow blowback into the building and shall be turned down at 90 degrees with a 6 mm [¼ inch] screen over the opening.

An exhaust fan shall be located as high as possible near the middle of the back wall of the booth. The fan shall be capable of an air flow of 42 m³/min. [1500 cfm] at 13 mm [½ inch] static pressure with an air control damper capable of a static pressure of 6 mm [¼ inches] water gauge at 42 m³/min. [1500 cfm] per minute. The damper control motor and exhaust fan motor shall be connected to a starting switch by wiring in accordance with NEC and local codes. The damper motor must be driven open with a spring return.

One 1200 mm [4 foot] fluorescent light shall be installed within the enclosure section of the hooded area.

The 1800 mm [6 foot] area of work bench directly under the hood and the 1800 x 900 mm [6 by 3 foot] area of floor directly in front of the hooded work bench area shall have an impervious smooth surface such that any liquids can be cleaned and removed readily.

- (f) Have a telephone, when required, in accordance with the provisions of Subsection 639.09.
- (g) Have the following testing equipment. The Maine Department of Transportation Independent Assurance Sampling and Testing program is conducted to monitor the precision and accuracy of Acceptance Tests. All testing equipment shall be of commercial quality and acceptable to the Engineer and all equipment determined to

be substandard by this testing program shall be replaced. The Contractor shall install and maintain the equipment in good condition at all times.

1. Electronic Digital balance 20 kg sensitive to 1 gram.
2. Electronic digital balance 2 kg minimum capacity sensitive to 0.1 gram and conforming to AASHTO M231 Class G2. If the 20 kg electronic balance is sensitive to 0.1 gram in the 0 to 2 kg range, then this balance will not be required.
3. Triple Beam Balance, 2.6 kg capacity, set up for running cores, conforming to AASHTO M231 Class G2.
4. Sample Splitter with pans, AASHTO T248, Method A.
5. Coarse series shaker: Mechanical shaker having trays with a minimum of 12 900 mm² [200 square inches] of surface area or; a manually operated shaker box manufactured to close conformity of the plans available at the MDOT Technical Services Division. Woven wire sieves conforming to the requirements of AASHTO M92. Sieve sizes 75 mm [3 inch], 25 mm [1 inch], 19 mm [$\frac{3}{4}$ inch], 12.5 mm [$\frac{1}{2}$ inch] sieves shall be provided for each type of shaker used.
6. Motorized Sieve Shaker, either a combination rocking and tapping action or rheostat controlled vibrating type. The shaker shall be capable of holding a nest of six 200 mm [8 inch] sieves and pan.
7. Set of U.S. Standard Brass or Stainless Steel 200 mm [8 inch] diameter woven wire sieves conforming to the requirements of AASHTO M92 and the sieves required shall include the following sizes:

Metric	English
25 mm	1 inch
19 mm	$\frac{3}{4}$ inch
12.5 mm	$\frac{1}{2}$ inch
9.5 mm	$\frac{3}{8}$ inch
6.3 mm	$\frac{1}{4}$ inch
4.75 mm	No. 4
2.36 mm	No. 8
2.0 mm	No. 10
two 1.18 mm	two No. 16
850 m	No. 20
600 m	No. 30
425 m	No. 40
300 m	No. 50
150 m	No. 100
two 75 m	two No. 200
two pans and covers	

8. Two Hot Plates, each with two burners 700 to 800 Watt, 3 prong grounded plug with adjustable control for each burner.
9. Four Drying Pans, 250 by 350 by 60 mm [10 by 14 by 2½ inch], sturdy construction.
10. Square ended shovel, long or short handle.
11. Two 500 ml squeeze bottles, 48 mm diameter cap.
12. Timer, attached to shaker or capable of being attached to shaker; 10 minute minimum time.
13. Four spoons, 300 mm [12 inch] handle or longer, heavy gage stainless steel.
14. Two 38 mm [1½ inch] paint brushes.
15. Nylon brush, 38 mm [1½ inch] diameter, wood handle.
16. Wire brush, 70 mm [2¾ inch] diameter, brass bristles.
17. Heat resistant long cuff gloves.
18. Oil Bath, 1.9 L [2 quart] wax warmer with oil or equivalent which will heat to 150 °C [300°F].
19. Two long stem thermometers, 44 mm [1¾ inch diameter] dial with pointed 200 mm [eight inch] stem accurate to one percent of dial capacity with a range of 10°C to 260°C [50°F to 500°F].
20. Armored thermometer, glass bulb enclosed in a nickel plated armor case, range 40°C to 230°C [100°F to 450°F].
21. Four 9.5 L [10 quart] galvanized steel pails for plants that require belt and pug mill samples and six 9.5 L [10 quart] galvanized steel pails for plants that require hot bin samples.
22. One standard household grade 600 watt microwave oven, with a minimum 0.03 m³ [1.2 cubic feet], vented to the outside. Three containers designed for microwave ovens that will hold a 2,500 gram sample.
23. One 1.5 x 1.5 m [5x5 foot] impervious vinyl coated nylon canvas.
24. Eye and skin neutralizer, three 0.45 L [16 ounce] sealed bottles of an aqueous sterile solution buffered to a neutral pH and capable of neutralizing acid and alkali burns of the eyes and skin. Bottles shall be placed in a clearly labeled wall mounted holder or station.

25. Be equipped with a gravity or pressure water system with at least 375 L [100 gallon] capacity. The tank shall be piped to a goose neck faucet at an approved sink within the laboratory. The sink shall have an outside drain.
26. Proportioned elongation caliper device meeting requirements of ASTM D4791 standard test method for Flat or Elongated Particles in Coarse Aggregate Section 6, Apparatus.
27. A ten person general purpose first aid kit.
28. One 9.5 L [10 quart] heavy duty, smooth, seamless stainless steel beaker with rolled top rim.

639.07 Testing Facilities - Concrete. The building and facilities shall:

- (a) The building shall be the same minimum size and quality as Field Office Type B placed in an approved location in the vicinity of the plant.
- (b) Have adequate heat and ventilation. The method of heating shall be such that a minimum temperature of 18°C [65°F] can be maintained at all times. During the months of June, July, August and September air conditioning shall be provided.
- (c) Be reserved for the exclusive use of the Engineer at the plant site whenever concrete is being provided for the project and remain available for the duration of the project.
- (d) Be equipped with a gravity or pressure water system with at least 375 L [100 gallon] capacity. The tank shall be piped to a gooseneck faucet at an approved sink within the laboratory. The sink shall have approved outside drainage.
- (e) Have a bench, 1500 mm [5 feet] long by 600 mm [24 inches] wide, 900 mm [3 feet] above the floor, suitable for supporting a sieve shaker and electric hot plate.
- (f) Have two electric wall outlets; one to be at least 20 amp Triplex, located near the bench described in (e) above.
- (g) Have a standard office desk, chair and one stool, 710 mm [28 inches] high.
- (h) Have a telephone, when required in accordance with the provisions of Subsection 639.09.
- (i) Be equipped with the following test equipment and supplies which conforms to the latest AASHTO revisions for AASHTO T27 and T21 or otherwise acceptable by the Engineer for Maine Department of Transportation test procedures.

The Maine Department of Transportation Independent Assurance sampling and testing program will be conducted to monitor the precision and accuracy of acceptance tests. All testing equipment shall be of commercial quality and acceptable to the Engineer and all equipment determined to be substandard for the

testing program shall be replaced. The Contractor shall install and maintain the equipment in good condition at all times.

1. Coarse series shaker: Coarse Series mechanical shaker trays with a minimum of 129 000 mm² [200 square inches] of surface area or a manually operated shaker box manufactured to close conformity of the plans available at the Maine Department of Transportation, Technical Services Division. Woven wire sieves conforming to the requirements of AASHTO M92. Sieve sizes of 50 mm [2 inch], 37.5 mm, [1½ inch], 25 mm [1 inch], 19 mm [¾ inch], 12.5 mm [½ inch] and 9.5 mm [⅜ inch] sieves shall be provided for each type of shaker used.
2. Fine aggregate mechanical sieve shaker with timer, having either rocking and tapping action or circular and tapping action with a capacity of not less than six full height sieves and one pan of 200 mm [eight inch] diameter.
3. Set of U.S. Standard Brass or Stainless Steel 200 mm [eight inch] diameter woven wire sieves conforming to the requirements of AASHTO M92 and the sieves required shall include the following sizes:

Metric	English
25 mm	1 inch
19 mm	¾ inch
12.5 mm	½ inch
9.5 mm	⅜ inch
6.3 mm	¼ inch
4.75 mm	No. 4
2.36 mm	No. 8
2.0 mm	No. 10
two 1.18 mm	two No. 16
850 m	No. 20
600 m	No. 30
425 m	No. 40
300 m	No. 50
150 m	No. 100
two 75 m	two No. 200
pan and cover	

4. Balance: At least 34 kg [75 pound] capacity, sensitive to 0.02 kg [0.05 pounds], conforming to AASHTO M231 Class G-100.
5. Electronic digital balance: 2000 gram capacity, sensitive to 0.1 gram, conforming to AASHTO M231 Class G2.
6. Two hot plates, double burner electric with two burners 700 to 800 watt, 3 prong grounded plug, with adjustable control for each burner.

7. Six Drying Pans: 250 mm by 375 mm by 50 mm deep [10 inch by 15 inch by 2 inch deep] heavy gauge aluminum.
8. Heat resistant long cuffed gloves.
9. Two D-Handle square end shovels, 240 mm [9½ inch] wide.
10. 1.5 by 1.5 m [5 by 5 foot] impervious vinyl coated nylon canvas for quartering samples.
11. One sample splitter; stainless steel, con- forming to AASHTO T248 paragraph 6.1, with curled safety edges.
12. Reference color comparison chart with five organic plate numbers, as described in AASHTO T21 paragraph 9.2., 350 ml [one 12 ounce] clear graduated glass bottle and reagent sodium hydroxide solution 3 percent or sodium hydroxide crystals in sufficient quantities for the duration of the project.
13. Moisture determination apparatus (speed moisture tester) calcium carbide type, 20 gram minimum size. Speedy moisture reagent in sufficient quantity for the duration of the project.
14. Concrete thermometer, -20°C to 105°C [0°F to 20°F].
15. Fire extinguisher, multipurpose (A, B, C) dry powder.
16. Miscellaneous small tools and equipment: one bench brush, floor broom, brass bristle sieve brush, two 38 mm [1½ inch] paint brushes, two 380 mm [15 inch] heavy gauge stainless steel spoons, and one 9.5 L [10 quart] heavy duty smooth, seamless stainless steel beaker with rolled top rim.
17. A ten person general purpose first aid kit.

639.08 Heat. When required, heat shall be supplied by the Contractor to maintain an acceptable room temperature during occupancy.

639.09 Telephone. The Contractor shall provide a telephone, touch tone models in areas where touch tone service is available, in all field offices for the exclusive use of the State personnel. This telephone shall be on a private line, if available and shall be listed under "State of Maine, Maine Department of Transportation". The Contractor shall be responsible for the installation charges and all reinstallation charges following suspended periods. Monthly service and maintenance charges shall be billed by the telephone company directly to the Contractor. During seasonal suspension periods, the telephone company shall be notified to discontinue or suspend the services and the Contractor shall assume all charges. Upon resumption of work the telephone service shall be reinstated.

The Contractor shall also provide a telephone answering device in all field offices where a telephone is provided capable of answering calls and recording incoming messages. The Contractor shall be responsible for all maintenance costs for the answering device.

639.10 Method of Measurement. Field office and testing facilities will be measured by the unit or lump sum for each building provided, equipped and maintained satisfactorily.

639.11 Basis of Payment. The accepted quantity of field office or testing facilities will be paid for at the contract unit price each or lump sum which payment shall be full compensation for furnishing, erecting, equipping, maintaining, furnishing electricity, heating, installing and maintaining toilet facilities and if necessary removing the buildings. Payment for testing facilities shall include furnishing all buildings and facilities as required by these specifications for the testing of materials by the State.

Payment for these items will be made in 3 parts; the first payment of $\frac{1}{2}$ to be made after the Contractor has supplied the building and it has been approved. The remaining payments shall be made at intervals as follows:

A second payment of $\frac{1}{4}$ shall be made when one-half of the anticipated work has been completed.

The final payment of the remaining $\frac{1}{4}$ shall be made upon completion of the work.

Testing facilities, bituminous liquids and portland cement, will not be paid for directly but all costs will be considered incidental to the various contract items.

Payment will be made under:

Pay Item	Pay Unit
639.18 Field Office Type A	Each
639.19 Field Office Type B	Each
639.21 Testing Facilities Soils	Lump Sum
639.22 Testing Facilities Bituminous Mixes	Lump Sum
639.23 Testing Facilities Concrete	Lump Sum

SECTION 640 -- MICROCOMPUTER SYSTEM

Reserved

SECTION 641 -- REST AREA FACILITIES

Reserved

SECTION 642 -- STEPS

642.01 Description. This work shall consist of the construction of wooden steps, precast concrete steps or cast-in-place concrete steps in accordance with these specifications and in reasonably close conformity with dimensions and designs shown on the plans.

MATERIALS

642.02 Materials. Materials for the steps shall meet the requirements as specified in the following Subsections of Division 700 -- Materials:

Exterior Ready Mixed Paint	708.01
Timber Preservative	708.05
Precast Concrete Units	712.06

Wood shall be well seasoned spruce or pine, Number 1 dimension lumber. Nails and hardware shall be galvanized.

Precast concrete steps shall conform to the specifications of precast units except as modified herein and shall be of the dimensions detailed on the plans or as otherwise approved. Exposed surfaces shall have a rubbed finish as specified in Subsection 502.14(d).

Cast-in-place concrete steps, shall conform to the requirements of Section 502 -- Structural Concrete, Class A.

CONSTRUCTION REQUIREMENTS

642.03 Wooden Steps. Wooden steps shall be fabricated and fastened in accordance with standard commercial building practices.

After members have been cut to size, the ends shall be soaked in an approved timber preservative. Prior to assembling the steps, all contact surfaces shall be painted 2 coats of paint, color to be designated. The first coat of paint shall be thinned.

642.04 Precast Concrete Steps. Precast concrete steps shall be placed on a compacted gravel bed with horizontal joints level and vertical joints plumb. The foundation shall be prepared in advance of setting the steps by grading and compacting the aggregate subbase to the proper elevation. The steps shall be set with a uniform tread width to match the finish grade of the slope. All remaining excavated areas surrounding the steps shall be filled to the required grade with approved materials and thoroughly tamped.

642.05 Cast-in-place Concrete Steps. Cast-in-place concrete steps shall conform to the applicable requirements of Section 502 -- Structural Concrete.

642.06 Method of Measurement. Wooden steps and precast portland cement concrete steps will be measured by each unit, complete in place and accepted.

Cast-in-place concrete steps will be measured for payment by the cubic meter [cubic yard] in place.

642.07 Basis of Payment. The accepted wooden steps will be paid for at the contract unit price each, complete and accepted in place which price shall be full compensation for furnishing all materials, labor and other incidentals necessary to complete the work.

The accepted quantity of precast concrete steps will be paid for at the contract unit price each, complete in place, which price shall be full compensation for furnishing and placing all materials including reinforcing steel.

Excavation and backfill will be measured and paid for as provided in Section 206 -- Structural Excavation.

The accepted quantity for cast-in-place concrete steps will be paid for at the unit contract price per cubic meter [cubic yard] complete in place which price shall be full compensation for furnishing and placing all materials including reinforcing steel.

Payment will be made under:

Pay Item	Pay Unit
642.12 Wooden Steps	Each
642.15 Precast Concrete Steps	Each
642.17 Cast-in-place Concrete Steps	cubic meter [Cubic Yard]

SECTION 643 -- TRAFFIC SIGNALS

643.01 Description. This work shall consist of furnishing and installing all equipment necessary for the erection and operation of a traffic signal, flashing beacon, temporary traffic signal or modification of a traffic signal, all in reasonably close conformity with the plans.

MATERIALS

643.02 General. All equipment shall be new unless otherwise specified. Substitutes for specified material will be accepted upon approval by the Engineer. Functionally, any substitute shall give equal or better service than the specified material. Existing signal equipment to be used shall be cleaned, repainted and reconditioned as noted on the plans. All equipment, installation of equipment and other incidental work shall conform to the latest applicable provisions of: NEC, MUTCD, NESC, NEMA and the ITE Standards for traffic control equipment. All work shall be done to the satisfaction of the Engineer. The meaning of specific terms shall be as defined in MUTCD, NESC and the ITE Standards for traffic control equipment.

643.021 Materials. Material shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Steel Conduit	715.02
Non-metallic Conduit	715.03
Prewired Conduit	715.04
Metallic Junction and Fuse Box	715.05
Secondary Wiring	715.07
Vehicular Signal Indications	718.01
Pedestrian Signal	718.02
Signal Mounting	718.03
Loop Vehicular Detectors	718.04
Microwave Detectors	718.05
Pedestrian Detectors	718.06
Controllers	718.07
Controller Cabinet	718.08
Flasher	718.09
Program Selection	718.10
Contacts and Relays	718.11
Conductors	718.12
Aluminum Supports	720.01
Aluminum Mast Arm and Bracket Arm	720.02
Steel Supports	720.03
Steel Mast Arm and Bracket Arm	720.04
Wood Utility Pole	720.10
Anchor Bolts	720.07

643.022 Paint. Aluminum paint shall conform to AASHTO M69, Type II. Green or yellow enamel paint, as indicated on the plans, shall meet or exceed the latest Federal Specification TT-E-489. The color shall match Federal Color Standard Number 14062.

643.023 Design and Fabrication. The design and fabrication of traffic signal support structures shall meet the requirements of the current edition of AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals" and interims thereto, except as otherwise indicated within these specifications or on the contract plans. All poles and mast arms shall be designed to withstand the maximum forces generated on the design configuration by the loads specified in Section 2 of the "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals", using the 50-year mean recurrence interval for wind speeds.

All welding shall conform to the applicable provisions of the latest edition of the AWS Structural Welding Code, Steel, D1.1 for steel construction, or the latest edition of the AWS Structural Welding Code, Aluminum D1.2 for aluminum construction.

After execution of the contract and before any shop work is commenced, the Contractor shall submit two sets of the manufacturer's drawings of all poles he proposes to furnish and erect under this Contract. The drawings shall be of sufficient detail to indicate material and dimensional conformance with these specifications and the contract drawings. Each drawing shall contain a reference to the design criteria and a certification that the design criteria have been met by the poles, mast arms and associated hardware and fittings, as submitted. The certification shall be signed by a Registered Professional Engineer under his official seal.

It is the intent of these specifications that the Contractor shall be fully responsible for the adequacy of the sizes, wall thicknesses, materials and connections of the poles, mast arms and associated hardware and fittings. Approval of the drawings by the Engineer will signify only approval of the materials, mounting height(s) and mast arm length(s). Approval of deviations from the contract drawings and/or specifications shall be requested in writing and approved by the Engineer before being incorporated in the manufacturer's drawings.

The Contractor shall furnish and install all electrical fittings, pipe, switches, fuses and such other material necessary to install the equipment properly and securely. All equipment shall conform to the applicable code and be of first- class workmanship. All electrical fittings shall be complete with weatherproof gaskets.

643.024 Miscellaneous Materials. Span wire shall be minimum 7.9 mm [5/16 inch] diameter, minimum, 7 strand, extra-high strength, galvanized steel wire. Anchors shall be power installed and sized according to strain and soil conditions. All hardware, such as strandwise feed-thru dead ends, preforming guy grip dead ends and angle thimble-eye bolts, shall be standard pole line hardware.

Guying of poles shall meet the requirements of Grade "B" Construction as defined in the NESC. Guys shall be installed in line with the direction of pull. Anchors shall be power installed so that the centerline of the anchor rod will be within 10° of the line of the guy wire. The holding capacity of the anchor shall be 1.25 times the calculated load on the guy wire. Guy wires shall be utility grade and the maximum working stress shall not exceed half of the maximum ultimate

tensile strength of utility grade guy strand. Where bed rock is encountered, rock anchors shall be used.

Pipe standoffs for sidewalk anchors shall be galvanized steel pipe sized according to the offset distance from anchor to pole and shall be fitted with standard guying hardware.

Messenger wire shall be 6 mm [1/4 inch] diameter, 7 strand, extra-high strength, galvanized steel wire, unless otherwise specified.

CONSTRUCTION REQUIREMENTS

643.03 General. Installation details will be shown on the plans. The location shown for all equipment and vehicle detectors is approximate; final locations will be determined in the field.

During installation, all heads installed but not operating shall be covered or otherwise concealed from view.

The requirements of certain Subsections of this specification may be waived for temporary traffic signals and traffic signal modifications, if so noted on the plans.

643.04 Poles. Wood poles shall be placed in the ground to a depth of 20 percent of their overall length, with a maximum deviation from the vertical of 6 mm in 1500 mm [1/4 inch in 5 feet].

After each wood pole has been set in the ground and plumbed, the space around the pole shall be backfilled with selected earth or sand, free of rocks and other deleterious material, placed in layers approximately 100 mm [4 inches] thick. Each layer shall be moistened and thoroughly compacted.

Strain poles, pedestal poles and mast arm poles shall be erected in a vertical position, with a maximum deviation from the vertical of 6 mm in 1500 mm [1/4 inch in 5 feet] using the leveling nuts provided with the anchor bolts. Once the poles have been plumbed, the top nuts shall be tightened by bringing the nut to a snug tight condition using the full effort of a worker using a spud wrench or compatible tool. After all nuts have been brought to a snug, tight condition, each nut shall be tightened an additional one-third turn, using an impact wrench, torque wrench or large crescent wrench. A minimum of two full threads shall project beyond the outside face of the nut. Nuts and bolts, other than anchor bolts, shall also be tightened by the above procedure.

When foundation and anchor bolts have been installed by others, the Contractor shall verify the anchor bolt dimensions at each location so that bases will be furnished with properly located and sized bolt holes.

Wires in poles shall be supported with a Kellum-type, braided, strain-relief grip attached to a "J" hook mounted inside the pole near the top.

643.05 Loop Detector and Loop Detector Wire Installation. The detector unit shall be located in the controller. No more than four loops shall be connected to a single detector amplifier.

Detectors shall be installed according to the manufacturer's recommendation, subject to approval. Each detector shall be supplied complete with comprehensive installation instructions.

The pavement slot for wire shall be 50 to 75 mm [2 to 3 inches] below the finished surface and not closer than 450 mm [18 inches] from the edge of pavement or the curb. The right-angle corners of the pavement slot shall be chamfered to eliminate sharp bends in the loop wires.

Loop detector wire shall be number 14 or number 12 AWG copper conductors drawn through vinyl plastic tubing approximately 6 mm [1/4 inch] in diameter. All pulse loop "approach" wiring shall be insulated red and shall be permanently marked "A", "B", "C", or "D", according to the "approach" guidelines in the controller cabinet. All pulse loop "presence" wiring shall be insulated black and shall be permanently marked according to the "presence" guidelines in the controller cabinet. All loop lead-ins shall be of the same conductor with no splicing. The lead-in from the amplifier to the beginning of the loop shall be shielded pairs, as shown on the plans.

All debris and moisture shall be removed from the loop pavement slot before installation of loop wires. The pavement slot shall be filled to the road surface with an approved sealing compound to form a waterproof bond with the pavement after installing the wire loop.

Detector conductors shall not be housed in the same jacket as the signal conductors.

643.06 Microwave Detector Installation. The microwave detector shall be installed in accordance with the manufacturer's recommendations. A four conductor wire shall be installed from the microwave unit to the controller. All angles and adjustment of patterns shall be the responsibility of the Contractor. The detectors shall operate in either pulse or presence mode.

643.07 Span Wire, Messenger Wire and Guy Wire. All span wire, messenger wire, and guy wire installations shall be in conformance with the requirements of the utility companies, when installed on utility poles.

All span wires, messenger wires, guy wires, terminal boxes, controller cabinets, or any other metallic surface that might be contacted by people, shall be bonded to ground.

All sidewalk guy wires and slant guy wires installed in a sidewalk area shall be equipped with full-round or half-round guy guards.

643.08 Conduit. All conductors under roadways from the controller to the mast arm poles shall be three inch schedule 80 PVC.

643.09 Service Connection. The Contractor shall furnish and install the necessary electrical service as directed by the utility company. The Contractor shall make all arrangements for the service connection and be responsible for all charges incurred thereby.

Under no condition shall any equipment, except that shown on the plans, be installed on any utility pole.

Whenever a service connection is to be made, the Contractor shall contact the utility involved and inform them of the location, pole number and time proposed for the service connection.

The Contractor shall be responsible for all outstanding bills for preliminary work done by the utility company during the installation of the traffic signal system, to facilitate the service connection.

A service ground rod shall be installed if the service meter trim is not grounded.

The Contractor shall be responsible for grounding the system to 5 OHMS or less. The grounding shall be performed using a ground meter with reference grounds. All testing will be done in the presence of the Engineer.

643.10 Wiring. The Contractor shall furnish and install sufficient cable and wire to operate the system properly as shown on the plans and as directed.

The following color code shall be used where possible:

Red	Red, artery
Orange Wire	Yellow, artery
Green Wire	Red, side street
Orange with Tracer	Yellow, side street
Green with Tracer	Green, side street
White and white with tracer	Common for all signals and bond
Blue	All steady burning arrows
Blue with Tracer	Intermittent arrows
Remaining	Detectors and pedestrian signals

The white wire and white wire with tracer shall be used for all common connections and it shall be continuously connected to ground at the controller.

There shall be no wire splices. Connections shall be made on a terminal board inside a watertight galvanized steel or aluminum junction box or in an aerial terminal enclosure with protective cover rated for 600 volts.

Spade type copper terminal ends shall be used to attach all conductors to terminals. All exposed metal parts, including service conduit and the controller cabinet shall be bonded and grounded.

Not more than 3 conductors shall be brought to any one terminal. Terminals shall be mounted to face the cabinet door.

The number and size of conductors required in each cable will be indicated on the plans.

643.11 Vertical Clearance. Vertical clearances for vehicular and pedestrian heads shall be in conformity with the MUTCD. All clearances shall be uniform among each type of head or mounting scheme. Clearance for mast arm pole and span wire mounted vehicular heads shall be 4.88 m [16 feet]; clearance for pole mounted vehicular heads shall be 3 m [10 feet]; clearance for pedestrian heads shall be 5.5 m [8 feet] unless otherwise specified. Clearance for span wire

mounted flashing beacon heads shall be a minimum of 5.2 m [17 feet] and a maximum of 5.5 m [18 feet].

643.12 Painting. All exterior parts of the following equipment shall be delivered to the project finished with green or yellow enamel:

Vehicular Signal Heads
Pedestrian Signal Heads
Pedestrian Push Button Detectors

The outside of the steel controller cabinet shall be painted with aluminum paint.

The Contractor shall apply one coat of green enamel to all existing equipment designated on the plans to be painted. The Contractor shall touch up all scratches on exposed surfaces of new equipment with matching enamel after the equipment has been installed.

All exposed signal parts to be painted shall be cleaned and shall be dry when the paint is applied. No painting shall be done in damp weather nor when the air temperature is below 4°C [40°F], unless otherwise permitted.

The Contractor shall identify recently painted equipment with "Wet Paint" signs, and shall be responsible for all claims for damages resulting from contact with wet paint surfaces.

643.13 Power Factor. In the event that the equipment is of such design that the power factor is reduced below the requirement of the utility company, the Contractor shall furnish and install, without further charge, all equipment necessary to restore the power factor to a satisfactory percentage. Such equipment shall be accessible and shall not be mounted on the utility company poles.

643.14 Field Tests. Prior to acceptance of the work, and in the presence of the Engineer the Contractor shall conduct the following tests on all traffic signal equipment and circuits.

- (a) Continuity. Each circuit shall be tested for continuity.
- (b) Ground. Each circuit shall be tested for grounds.
- (c) Megger. Megger tests at 500 volts DC shall be made on each circuit between the circuit and a ground. The insulation resistance shall not be less than 1000 s [10 megohms] on all circuits, except for inductive loop detector circuits which shall have an insulation resistance value of not less than 10,000 s [100 megohms].
- (d) Loop Inductance. A loop test meter shall be used to determine that the inductance of the installed loop and lead-in are within the tuning range recommended by the loop detector manufacturer.
- (e) Functional. A functional test shall be made in which it is demonstrated that each part of the system functions as specified.

The functional test for each new or modified traffic signal and flashing beacon shall consist of not less than 10 days of continuous satisfactory operation. If unsatisfactory performance of the system develops, the condition shall be corrected and the test shall be repeated until the 10 days of continuous satisfactory operation is obtained.

The initial operation shall be made between 9:00 A.M. and 2:00 P.M. unless specified otherwise. Prior to initial operation, all equipment shown on the plans shall be installed and operable.

Initial operation of new or modified traffic signal systems shall be made only after all traffic signal circuits have been thoroughly tested as specified above.

During the test period all costs except electrical energy shall be the Contractor's responsibility.

Functional tests shall start on any working day except Friday or the day preceding a legal holiday.

Shutdown caused by a power interruption shall not constitute discontinuity of the functional test, however, the test shall continue after power is restored.

643.15 Timing. The controller shall be timed as noted on the plans. The Contractor shall notify the Engineer, at least 1 week in advance, of his intention to initially operate the signals.

At the time of initial operation of the new signals, the Contractor shall provide police protection from the local police department at the Contractor's expense until the Contractor demonstrates to the Engineer that the signal operates in conformance with the specification.

643.16 Final Cleaning Up. After all work has been completed, the Contractor shall remove all barriers, "Wet Paint" signs, equipment and all debris which has accumulated during the work.

Unless otherwise specified in the plans, the Contractor shall remove and deliver all unused signal equipment and wiring to the State of Maine, Department of Transportation, as directed by the Engineer. The Contractor shall notify the State Traffic Engineer (207-289-3775) as to time and date of such delivery. (Deliveries will be accepted Monday through Friday between the hours of 7:00 A.M. and 4:00 P.M. only.) Notification shall proceed delivery by a minimum of 24 hours.

643.17 Documents. The Contractor shall furnish two operation and maintenance manuals for all controller units, auxiliary equipment, vehicle detector sensor units, control units and amplifiers. Documents shall be delivered with the controller at the time of testing. Each manual must include, but need not be limited to the following:

- (a) An explanation of the theory of operation, including a functional description and a detailed circuit description.
- (b) A schematic diagram of each unit. A cabinet wiring diagram including all field wiring and pin locations and designations for all plug type connectors.

If any circuit changes are made in the field, the changes shall be noted on the schematic diagrams.

- (c) A trouble shooting and preventive maintenance procedure including both field and bench trouble shooting analysis.
- (d) A parts list including a pictorial diagram showing the location and identification of each component on the chassis or circuit board.
- (e) A drawing of the controller cabinet interior showing the location of all shelves, terminal blocks, relays, timers, loop amplifiers.

In addition, manufacturer's warranties and guarantees for materials shall be delivered to the Engineer prior to acceptance of the project.

643.18 Method of Measurement. Traffic signals, traffic signal modifications, interconnect wire and flashing beacons will each be measured for payment by the lump sum in place. Temporary traffic signals will be measured for payment by the lump sum, satisfactorily installed, operated, and removed.

Pedestal poles, strain poles, combination poles, and mast arm poles with mast arms will be measured by each unit.

643.19 Basis of Payment. Traffic signal modifications, traffic signals, interconnect wire and flashing beacons will be paid for at the contract lump sum price, which payment will be full compensation for furnishing and installing all materials, both new and reused, including, but not limited to wood poles, span wire, guys, controllers, vehicular heads, pedestrian heads, flashing beacons, wiring, cable, pole risers and all appurtenances and incidentals required for a complete functioning installation and for furnishing all tools and labor necessary for completing the installation. Conduits, junction boxes and foundations will be paid for under Section 626 -- Foundations, Conduit and Junction Boxes for Highway Signing, Lighting and Signals.

Pedestal poles, strain poles, combination poles and mast arm poles with mast arms will be paid for at the contract unit price each which payment shall be full compensation for furnishing and installing all materials, tools and labor necessary to erect the poles.

Payment for temporary traffic signals shall include compensation for the removal of the system upon completion of the work. All materials used for temporary traffic signals will remain the property of the Contractor. Operating the controller by hand will be paid for under Section 629 -- Hand Labor.

Payment will be made under:

Pay Item	Pay Unit
643.60 Flashing Beacon at : ____	Lump Sum
643.71 Traffic Signal Modification: ____	Lump Sum
643.72 Temporary Traffic Signal: ____	Lump Sum
643.80 Traffic Signals at: ____	Lump Sum

643.90 Interconnect Wire Between: ____	Lump Sum
643.91 Mast Arm Pole	Each
643.92 Pedestal Pole	Each
643.93 Strain Pole	Each
643.94 Dual Purpose Pole	Each

SECTION 644 -- GLARE BARRIER

Reserved

SECTION 645 -- HIGHWAY SIGNING

645.01 Description. This work shall consist of furnishing and installing new signs, sign supports, delineators, and breakaway devices and removing, relocating or modifying existing signs and sign supports, in accordance with these specifications and in reasonably close conformity with the plans.

MATERIALS

645.02 General. All equipment shall be new unless otherwise specified. Substitutes for specified material will be accepted, if approved. Substitutes shall give equal or better service than the specified material. Where an existing system is to be modified, the existing material shall be removed, upgraded or disposed of as shown on the plans or as directed.

645.021 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Reflective Sheeting	719.01
Demountable High Intensity Reflectorized Letters, Numerals, Symbols and Borders	719.02
Aluminum Extrusions	719.03
Aluminum Sheets	719.04
Plywood	719.05
Demountable Reflectorized Delineators	719.06
Assembly Hardware	719.07
Aluminum Supports	720.01
Steel Supports	720.03
Steel H-beam Poles	720.06
Anchor Bolts	720.07
U-Channel Posts	720.08
Wood Sign Posts	720.12

Paint for the edge and back of plywood and field coat paint for wood sign posts shall be an exterior grade dark green enamel conforming to Federal Specifications TT-P-71b.

645.022 Sign Layout Drawings. The Contractor shall submit two sets of sign-face, layout-detail, and scale drawings. Fabrication of the signs shall not begin until the Contractor has received approval of these drawings. The drawings shall contain complete detailed information and dimensions. One set of drawings will be returned to the Contractor, who will make corrected drawings, if required. The drawings shall be detailed using the same units used on the plans.

645.023 Support Structures. The design, materials and fabrication of sign support structures shall meet the requirements of the current edition of AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals" and interims thereto, except as otherwise indicated within these specifications or on the plans. Bridge and pole mounted signs and their supports shall be designed using wind speeds as determined from the 25 year mean recurrence interval Isotach map. Bridge-type, cantilever-type and butterfly-type sign supports and associated signs and hardware shall be designed using the wind speeds as determined from the 50 year mean recurrence interval Isotach map, as contained in the above referenced AASHTO Specifications. For sign supports mounted on structures and approaches to structures, the mounting height shall be measured from the following:

For bridges over bodies of water: above the prevailing water level or, in the case of tidal waters, above mean high tide.

For overpass structures: above the lower roadway level.

For approach ramps: above the average adjacent ground level, if said ground level is more than 3 m [10 feet] below the base of the light standard.

All welding shall conform to the applicable provisions of the latest edition of the AWS Structural Welding Code, Steel, D1.1, for steel construction, or to the latest edition of AWS Structural Welding Code, Aluminum, D1.2 for aluminum construction.

Before any shop work is commenced, the Contractor shall submit two sets of drawings of all sign supports proposed to be furnished and erected under this contract. The drawings shall be of sufficient detail to indicate material and/or dimensional conformance with these specification and the contract drawings and, in the case of bridge, cantilever and butterfly type sign supports, shall be sufficiently detailed to show all structurally significant details. Approval for deviations from the contract drawings and/or specifications shall be requested in writing and shall be approved before being incorporated in the manufacturer's drawings.

- (a) Pole mounted signs. The poles for pole mounted signs shall be of the size, material and shape designated on the design drawings. The Contractor shall be fully responsible for the adequacy and design of any structural details not shown on the design drawings, and each drawing shall contain a reference to the design criteria and a certification by a Registered Professional Engineer, over his official stamp, that said design criteria have been met by all parts of the structure designed and/or detailed by the Contractor. Approval of the drawings will signify only approval of the size, material and length of the pole.
- (b) Bridge, Cantilever and butterfly type sign supports. The Contractor shall be responsible for the design of the support structure including its foundation(s). In addition to the required detail drawings he shall submit three copies of the design computations for the entire structure, including its foundation(s). The computations

shall be sufficiently detailed to allow the Engineer to check and approve the computations. Computer printouts will not be accepted unless they meet the above criteria. All drawings and computations shall be signed by a Registered Professional Engineer. Approval will be on the basis of the applicable provisions of Subsection 105.02.

- (c) Overpass mounted sign supports. Overpass mounted sign supports shall be constructed to the configuration and sizes and of the material shown on the contract plans. Approval will be on the basis of the applicable provisions of subsection 105.02.

Breakaway supports for sign supports will be required only for those locations indicated on the contract plans. Breakaway supports using load-concentrating couplings shall be supplied for use at all locations designated as breakaway, except that, for steel sign supports, slip bases may be used as an alternate. Breakaway devices other than the above may be used subject to the approval of the Engineer and subject to the applicable provisions of Section 721 -- Breakaway Devices. On multi-pole sign supports designated as breakaway, each pole shall be equipped with breakaway hinges immediately below the lower edge of the sign. Hinges relying on the friction between the hinge and the pole face for transmitting the design moment will not be accepted for use.

645.03 Classification of Signs. Sign sizes, color and legend designs shall conform to these specifications, the plans and MUTCD requirements. The signs are classed according to the intended use as follows:

- (a) Type I guide signs shall consist of high intensity, reflectorized sheeting or reflectorized, demountable letters, numerals, symbols and border mounted on an engineering grade, reflective sheeting background adhered to a sign panel constructed of extruded aluminum planks.
- (b) Type I regulatory, warning and route marker assembly signs shall consist of engineering grade, reflective sheeting letters, numerals, symbols and border on an engineering grade, reflective sheeting background adhered to a sign panel constructed of sheet aluminum.
- (c) Type II guide signs shall consist of engineering grade, reflective sheeting letters, numerals, symbols and border on an engineering grade, reflective sheeting background attached to a sign panel constructed of plywood.
- (d) Type II regulatory, warning and route marker assembly signs shall consist of engineering grade reflective sheeting letters, numerals, symbols and border on an engineering grade reflective sheeting background adhered to a sign panel constructed of sheet aluminum or plywood.

CONSTRUCTION REQUIREMENTS

645.04 Fabrication of Type I Guide Signs.

- (a) Panels. The panels for this type sign shall be shop-fabricated from aluminum planks to the sizes designated on the approved shop drawings. Cut edges shall be true and smooth and free from burrs or ragged breaks. Flame-cutting will not be permitted. Bolt holes may be drilled to finished size or punched to finished size, provided the diameter of the punched hole is at least twice the thickness of the metal being punched.

Fabrication of extruded aluminum sign planks, including punching or drilling holes and cutting to length, shall be completed prior to the metal degreasing and the application of the reflective sheeting. The bolts required to fasten the extruded aluminum planks together shall conform to the designs used in standard commercial processes for the type of extruded aluminum panels to be used as approved.

All route shields shall be on an overlay aluminum sheet of 2 mm [0.080 inch] minimum thickness and shall be in full color with reflective background; they shall not have demountable numerals and borders.

- (b) Reflective Sheeting. The engineering grade reflective sheeting shall be applied to the extruded aluminum plank in accordance with the current recommendations of the sheeting manufacturer.

The reflective sheeting shall cover the complete panel and shall not be trimmed to conform with the border. The reflective sheeting shall overlap into the side recess of the individual planks. There shall be no paint applied to the sign panels. The surface of all completed sign panels shall be flat and free of defects. Extruded aluminum molding shall be placed on the edges of the extruded panels, as shown on the plans.

- (c) Text. The design of upper and lower case letters, numerals and symbols, and the arrangement and spacing of texts shall be as provided on the plans and in conformance with the MUTCD.

Text for Guide Signs shall be composed of demountable letters, numerals, symbols and borders and shall be high-intensity, reflective sheeting. The demountable text shall be applied to the panels by use of aluminum pop rivets, in accordance with standard commercial processes, as approved. All demountable letters, numerals, symbols and borders shall be the same manufacturer's make for the entire project. Cutout high-intensity, reflective sheeting text shall be applied to the sign panel with a precoated, adhesive backing.

645.041 Fabrication of Type I Regulatory, Warning and Route Marker Assembly Signs and Type II Sheet Aluminum Regulatory, Warning and Route Marker Assembly Signs.

- (a) Panels. Sheet aluminum sign panels shall be shop-fabricated to the size shown on the plans. The corners shall be rounded to the indicated radius where shown.

Bolt holes may be drilled or punched to finished size, provided the diameter of the punched hole is at least twice the thickness of the metal being punched. Cut edges

shall be true and smooth and free from burrs or ragged breaks. Flame-cutting will not be permitted. Punching or drilling of holes and cutting to size shall be completed prior to metal degreasing and the application of reflective sheeting.

- (b) Reflective Sheeting. The engineering grade reflective sheeting shall be applied to the sheet aluminum sign panels in accordance with the current recommendations of the sheeting manufacturer. The reflective sheeting colors shall conform to the MUTCD standard highway sign colors for each type of sign. Surface of all panels shall be flat and free from defects.
- (c) Text. The text for regulatory, warning, confirmation and route marker assembly signs shall be composed of: cutout engineering grade, reflective sheeting letters, numerals, symbols and borders; or the silver letters may be formed by applying transparent ink to the reflective sheeting background where the silk screen process is used; or other methods to form the text may be used, when approved in advance.

645.042 Fabrication of Type II Guide Signs and Type II Plywood, Regulatory, Warning and Route Marker Assembly Signs.

- (a) Panels. Fabrication of all sign panels from high-density, overlaid plywood shall be performed in a uniform manner. All fabrication, including cutting, drilling, and edge routing, shall be completed prior to painting and application of reflective sheeting to the high-density, overlaid plywood. Panels shall be cut to size and shall be plywood. Panels shall be cut to size and shall be free of warping, open checks, open splits, open joints, open cracks, loose knots and other defects resulting from fabrication. Corners shall be left square. The surface of all sign panels shall be flat.

The edge and back of the plywood shall be painted with an exterior grade dark green paint.

- (b) Sign blanks shall be cut to shape using a saw blade that does not tear plywood grain. Holes shall be clean-cut and uniform. All cracks, open checks, open splits and other defects occurring on the edge surfaces shall be filled with a synthetic wood filler and sanded smooth prior to sealing and painting. The sign blank edges shall be sealed using an approved sealer/primer. The edges shall then be painted with an exterior grade, dark green paint.

The surface shall not be painted prior to application of reflective sheeting. Before applying reflective sheeting, dirt or wax shall be removed by one of the following methods:

1. The surface shall be buffed lightly with solvent-soaked steel wool, fine or medium, using organic solvents, such as lacquer thinner, xylol, heptane, benzene or naphtha, and wiped dry with clean cloths.
2. The panel shall be sanded lightly with fine-grade paper, cleaned with solvent and wiped dry using clean cloths.

- (c) Reflective Sheeting. The engineering grade reflective sheeting shall be applied directly to the cleaned high-density surface in accordance with the recommendations of the reflective sheeting manufacturer.
- (d) Text. The text for regulatory, warning, confirmation and route marker assembly signs shall be composed of cutout, engineering-grade reflective sheeting letters, numerals, symbols and borders or the silver letters may be formed by applying transparent ink to the reflective sheeting background where the silk screen process is used. Other methods to form the text may be used when approved in advance.

The design of the letters, numerals, and symbols, the spacing of the text and the size and spacing of the border shall conform to the MUTCD Standard Highway Signs.

645.05 Vacant

645.06 Installation of Type I Signs. The sign locations shown on the plans are approximate; exact locations will be determined in the field by the Engineer. Signs stockpiled prior to erection shall be stored in a vertical position and completely covered to avoid staining, weathering and dirt accumulation.

- (a) Sign Supports. Poles for single and multiple support roadside signs shall be erected plumb, using the leveling nuts supplied with the anchor bolts. When signs are supported by more than one pole, all poles shall be carefully aligned to avoid warping of the sign panel.

Bridge, butterfly and cantilever type sign supports and their foundations shall be constructed, assembled and erected, in accordance with the manufacturer's details, as approved. All horizontal supports spanning the roadway shall be level and shall be cambered to remain level under full dead-load. If, at any time after their erection, bridge, butterfly or cantilever type sign supports are to remain for a period in excess of 48 hours without the sign(s) for which they were designed being in place, suitable vibrationdampening devices, approved by the Engineer, shall be installed until such time as the sign(s) can be erected.

Bridge-mounted sign supports shall be fabricated and assembled in accordance with the details as shown on the contract drawings and with Section 504 -- Structural Steel; in addition, if required to be painted, they shall be painted in accordance with Section 506 -- Painting Structural Steel.

Where aluminum surfaces are in contact with concrete or dissimilar metals, the contacting surface shall be thoroughly coated with an approved, aluminumimpregnated caulking compound or the surfaces shall be separated by another approved material. Before signs are attached, aluminum sign supports shall be cleaned of all dirt and discoloration using methods recommended by the manufacturer.

- (b) Sign Panels. Extruded aluminum planks for sign panels shall be bolted together, as indicated on the plans. Extruded aluminum molding shall be placed on the

edges of the extruded panels. Sign panels shall be attached to the posts to provide the vertical and horizontal clearances from the roadway as indicated on the plans. Sign panels on overhead structures shall provide a minimum clearance of 5.2 m [17 feet] to the roadway surface. Sign panels on bridge-mounted sign supports shall be installed with the bottom edge of the sign 25 mm [1 inch] above the bottom of the bridge beam.

Sign panels mounted over the roadway shall tilt in the direction of the approaching traffic in such a manner that the angle between the sign face and the roadway grade, at the sign location shall be 85 degrees, plus or minus 3 degrees.

Ground-mounted signs located 1.2 m to 9 m [4 feet to 30 feet] from the edge of shoulder shall form an angle of 93 degrees between the approach roadway and the sign.

Signs located more than 9 m [30 feet] from the edge of the shoulder shall form an angle between the approach roadway and the sign face equal to 87 degrees minus 1 degree for each additional 3 m beyond 9 m [10 feet beyond 30 feet].

Unless otherwise shown on the plans, or designated by the Engineer, a minimum lateral clearance of 1.2 m [4 feet] shall be provided between the edge of the shoulder and the edge of any sign panel.

The elevation of the bottom edge of guide sign panels shall be 2.1 m [7 feet] above the elevation of the edge of the traveled way, at the sign location, or in case of a curb section, 2.1 m [7 feet] above the elevation of the outer edge of the roadway, unless authorized otherwise.

Signs located 9 m [30 feet] or more from the edge of traveled way shall be 1.5 m [5 feet] above the elevation of the edge of shoulder.

In the event that a second sign is to be placed under the main sign, the elevation of the bottom edge of the principal sign shall be a minimum of 2.4 m [8 feet] above the outer edge of the traveled way, or a minimum of 2.4 m [8 feet] above the edge of the traveled way, in curbed sections; the bottom edge of the second sign must be at least 1.5 m [5 feet] above the edge of the travelled way.

The elevation of the bottom edge of the regulatory, warning and route marker sign panels shall be 1.8 m [6 feet] above the elevation of the edge of the pavement, or edge of roadway in curbed sections, at the sign location. The elevation of the bottom edge of these sign panels above the elevation of the edge of the pavement on all crossing or connecting roadways shall be 1.5 m [5 feet] in rural areas or 2.1 m [7 feet] in urban areas. Field conditions may require some variation in elevations, as directed.

Each sign shall have at least two fasteners connecting it to the sign poles, except signs of 300 mm [1 foot] or less in height may have one fastener.

645.061 Installation of Type II Signs. The exact sign locations will be determined in the field. Signs stockpiled prior to erection shall be stored in a vertical position and completely covered to avoid staining, weathering and dirt accumulation.

- (a) Sign Supports. Support posts for Type II signs shall be U-channel posts weighing 3.7 kg/m [2½ pounds per foot] for signs of less than 0.37 m² [4 square feet] in area, 100 by 100 mm [4 inch by 4 inch] wood posts for signs of area 0.37 m² to 0.84 m² [4.00 to 8.99 square feet], 100 by 150 mm [4 inch by 6 inch] wood posts for signs of area 0.84 m² to 1.49 m² [9 to 15.99 square feet], and 150 mm by 150 mm [6 inch by 6 inch] wood posts for signs of area over 1.49 m² [16.00 square feet]. All signs 1500 mm [60 inches] wide or wider shall be mounted on two wood posts. Wood posts shall be set to a depth of 1.2 m [4 feet]. U-channel posts shall be set to a minimum depth of 760 mm [30 inches]. When it is necessary to set sign posts in bedrock, holes shall be excavated to the required depth and size at the locations indicated on the plans. The excavated material will be satisfactorily disposed of, as directed, and the posts set to the required depth.

When installing pressure-treated sign posts, the cut end of the posts shall not be buried in the ground.

Backfilling around the posts shall be with excavated material unless the excavated material is considered unsatisfactory, in which case the backfill shall be granular material conforming to the requirements of Subsection 703.19 -- Material for Embankment Construction. Backfill shall be thoroughly tamped in layers not exceeding 200 mm [8 inches] in depth.

When directed, the area around the posts shall be loamed and seeded in accordance with the applicable provisions of Section 615 -- Loam and Section 618 -- Seeding Method No. 1.

The Contractor shall be responsible for and shall repair all damage to underground drainage structures, utilities or lighting conduits encountered during placing the posts.

- (b) Mounting. Type II signs shall be mounted using assembly hardware specified in Subsection 719.07.

645.062 Installation of Delineators. Posts for delineators shall be erected so that posts and assemblies will be plumb. All posts which are bent or otherwise damaged shall be removed and properly replaced. Posts shall be driven 1200 mm [4 feet] from the outside edge of shoulder, 1200 mm [4 feet] from the face of curb and 1200 mm [4 feet] from the normal edge of shoulder in guardrail sections. A suitable driving cap shall be used and after driving, the top of the post shall have substantially the same cross sectional dimensions as the body of the post.

When bedrock is encountered in erecting posts, the depth to be drilled into the rock shall be determined by the Engineer.

After the posts are driven, delineators shall be mounted 1200 mm [4 feet] above the elevation of the edge of the traveled way. In the event that a delineator is required to be installed on a bridge structure, it shall be installed by use of a bracket as shown on the plans.

645.063 Installation of Breakaway Devices. Breakaway devices shall be installed at locations indicated on the plans by an approved method. Each sign and pole shall be carefully demounted for reinstallation at the same or at a new location. Manufacturer's installation information shall be provided on the project.

If required, poles shall be cut in such a manner that no rough edges will remain. No flame cutting will be permitted. Cut edges on steel poles shall be painted in accordance with Subsection 645.07.

Existing foundations shall be modified for attachment of the breakaway device as shown on the plans or approved.

Breakaway devices shall be attached to new foundations in accordance with the recommendations of the breakaway device manufacturer and as approved.

645.07 Demounting and Reinstalling Existing Signs and Poles. Signs and poles designated to be demounted and not designated to be reinstalled, except those designated to be demounted by others, shall be delivered to the Engineer.

Existing sign panels, poles, foundations and sign hardware, damaged as a result of the Contractor's operations shall be replaced or repaired by the Contractor to the satisfaction of the Engineer.

New or relocated regulatory, warning, confirmation or route marker assembly signs shall be installed the same working day as the corresponding existing signs are demounted. All new or relocated guide signs shall be installed within two working days of the time the corresponding existing sign is demounted. Before the Contractor demounts any regulatory or warning sign he shall erect a similar easel mounted sign at a designated location. The Contractor shall maintain this temporary sign in place until the permanent sign is installed.

Existing signs and poles shall be reinstalled in accordance with the applicable requirements for installing new signs and poles.

Relocated steel posts and clamps shall be field painted two coats after the posts have been erected. The first coat shall be a zinc-dust primer paint meeting Federal Specification TT-P-641B Type II. The second coat shall be bright aluminum paint, aluminum-dust Type II, Class 3 brightness, meeting Federal Specification TT-A-468 with a minimum of 0.24 kg/L [2 pounds per gallon], with vehicle meeting or exceeding Federal Specification TT-V-109. Scratches shall be touched up after the erection of the sign panels. The touchup shall be with both primer and finish coat. Sign pole surfaces to be painted shall be cleaned and dry when the paint is applied. No painting shall be done in damp weather nor when the air temperature is below 4 °C [40°F].

645.08 Method of Measurement. Demount Signs, Demount Poles, Reinstall Signs and Reinstall Poles will be measured by each unit.

Bridge, cantilever and butterfly type sign supports, including the foundations, support structures and sign panels, complete in place, as called for on the plans, will be measured by each unit.

Guide signs-overpass mounted, including supports, will be measured by each unit in place.

Breakaway devices (one per pole), shall be measured by the unit complete in place and accepted.

The area of roadside guide signs, regulatory, warning, confirmation and route marker assembly signs of the respective types, will be measured by the area in square meters [square feet], computed to nearest hundredth of a square meter [hundredth of a foot], as determined by the overall height multiplied by the overall width.

Aluminum poles for roadside guide signs, Type I will be measured by the number of units of each diameter, complete in place. Steel H-beam poles will be measured for payment by the kilogram [pound], determined from the nominal weight per meter [linear foot] for each size and the lengths as indicated on the plans.

Demountable reflectorized delineators will be measured by the number of units of each type in place.

645.09 Basis of Payment. The accepted demounted signs and demounted poles will be paid for at the contract unit price each for the respective item specified. Such price will be full compensation for delivering signs and poles not to be reinstalled to a site designated by the Engineer, and all other incidentals necessary to complete the work.

The accepted reinstalled signs or reinstalled poles will be paid for at the contract unit price each. Such price will be full compensation for furnishing new hardware, when required, and all incidentals necessary to complete the installations. All signs or poles designated to be reinstalled which are damaged by the Contractor shall be replaced by the Contractor with new signs or poles conforming to the applicable Specifications at no additional cost to the State.

The accepted bridge, cantilever and butterfly type sign supports will be paid for at the contract lump sum price for the respective items. Such price will be full compensation for the signs, support structures, foundations and incidentals necessary to complete the work.

The accepted guide signs-overpass mounted, will be paid for at the contract lump sum price for the respective items, which price will be full compensation for the signs, supports and incidentals necessary to complete the work.

The accepted roadside guide signs and regulatory, warning, confirmation, and route marker assembly signs will be paid for at the contract unit price per square meter [square foot]. Such payment will be full compensation for furnishing and installing signs, assembly hardware and all incidentals necessary to complete the work.

The accepted aluminum poles will be paid for at the contract unit price each for the specified diameter, complete in place.

The accepted demountable reflectorized delineators will be paid for at the contract unit price each for the type specified, which payment will be full compensation for delineator and post or bridge rail mounting, complete in place.

Payment for breakaway devices shall be full compensation for furnishing and installing the device, all required pole cutting, for adapting the pole to the breakaway device, for adapting the concrete base to the breakaway device and all other incidentals necessary to complete the work. Separate payment will be made at the respective contract unit prices for demounting and reinstalling the signs and the poles at multi-pole installations. At single-pole installations, separate payment will be made at the respective contract unit prices for demounting and reinstalling the poles only.

The accepted quantity of steel H-beam poles will be paid for at the contract unit price per kilogram [pound], complete in place as shown on the plans or as designated.

Furnishing and installing posts for Type II signs, including earth excavation and backfilling, furnishing and placing assembly hardware, backfilling material, loam, seed and other incidentals, will not be paid for directly but will be considered incidental to the cost of the signs they support.

Excavating rock will be paid for as provided in Section 206 -- Structural Excavation.

Payment will be made under:

Pay Item	Pay Unit
645.103 Demount Guide Sign	Each
645.106 Demount Regulatory, Warning, Confirmation and Route Marker Assembly Sign	Each
645.108 Demount Pole	Each
645.113 Reinstall Guide Sign	Each
645.116 Reinstall Regulatory, Warning, Confirmation and Route Marker Assembly Sign	Each
645.118 Reinstall Pole	Each
645.12 Overhead Guide Sign: ____	Lump Sum
645.13 Guide Sign-Overpass Mounted: ____	Lump Sum
645.14 Special Work No.: ____	Lump Sum
645.15 Cantilever Guide Sign	Lump Sum
645.161 Breakaway Device Single Pole	Each
645.162 Breakaway Device Multi Pole	Each
645.251 Roadside Guide Signs, Type I	square meter [Square Foot]
645.261 Bridge Guide Sign, Type I	square meter [Square Foot]
645.271 Regulatory, Warning, Confirmation and Route Assembly Sign, Type I	square meter [Square Foot]
645.281 125 mm [5 Inch] Aluminum Pole	Each
645.282 150 mm [6 Inch] Aluminum Pole	Each
645.283 175 mm [7 Inch] Aluminum Pole	Each
645.284 200 mm [8 Inch] Aluminum Pole	Each
645.285 250 mm [10 Inch] Aluminum Pole	Each
645.286 300 mm [12 Inch] Aluminum Pole	Each
645.289 Steel H-Beam Poles	kilograms [Pounds]
645.291 Roadside Guide Signs Type II	square meter [Square Foot]
645.292 Regulatory, Warning, Confirmation and Route Marker Assembly Signs Type II	square meter [Square Foot]

645.301	Demountable Reflectorized Delineator, Single	Each
645.302	Demountable Reflectorized Delineator, Double	Each

SECTION 646 -- EMBANKMENT STABILITY CONTROL DEVICES

Reserved

SECTION 647 and 648 VACANT

SECTION 649 -- PIPELINE PROTECTION

Reserved

SECTION 650 -- RAILROAD SIGNALS

Reserved

SECTION 651 -- RAIL-HIGHWAY CROSSING

Reserved

SECTION 652 -- MAINTENANCE OF TRAFFIC

652.01 Description. This work shall consist of furnishing, installing, maintaining and removing traffic control devices necessary to provide reasonable protection for motorists, pedestrians and construction workers in accordance with these Specifications, the applicable provisions of Subsection 104.04 and the plans.

Traffic control devices include signs, signals, lighting devices, markings, barricades, channelizing and hand signaling devices and flaggers.

MATERIALS

652.02 General. All traffic control devices shall conform to the requirements of Part VI of the latest edition of the MUTCD.

All signs, barricades, drums and vertical panel markers shall be reflectorized with construction grade reflective sheeting conforming to Subsection 719.01. Both the orange and white areas of drums, barricades and panel markers shall be reflectorized.

Construction signs shall be fabricated from materials that are flat, free from defects, reflectorized and of sufficient strength to withstand deflections using a windspeed of 130 km/hr [80 miles per hour].

All barricades, cones, drums, and construction signs may be constructed from new or recycled plastic.

652.03 Signs. Only signs with symbol messages conforming to the design of the Manual of Uniform Traffic Control Devices shall be used unless the Engineer approves the substitution of word messages.

652.04 Flashing Arrow Board. The flashing arrow board shall consist of at least 15 hooded amber sealed beam lamps arranged to present 4 horizontal messages; left arrow, right arrow, double arrow, light bar only. In the three arrow signals, the second light from the arrow point shall not operate. The arrow shall be mounted on at least a 1200 mm by 2400 mm [4 by 8 foot] flat black board with the bottom of the sign approximately 2100 mm [7 feet] above ground.

Circuitry shall be solid state. The arrow board shall be equipped with a manual control and a solid state photocell control to reduce intensity a minimum of 50 percent when ambient light falls below 54 lx [5 foot candles].

Each flashing light shall use Lamp No. 4412 A, sealed beam par 46, 8800 candlepower with a flash rate not less than 25 per minute, dwell time 50 percent per cycle.

Power for the flashing arrow board shall be from a selfcontained generator unit, of sufficient power to operate the lamps at their rated output or commercial power if available.

The flashing arrow board with generator and independent power drive shall be mounted on a pneumatic tired trailer vehicle or other suitable support for hauling to various locations as directed.

652.05 Other Devices. Vertical panel markers shall be orange and white striped, 200 mm wide by 600 mm high [8 inches wide by 24 inches high].

Cones shall be orange in color and not less than 450 mm [18 inches] in height. When used at night, cones shall be at least 710 mm [28 inches] high and reflectorized. Retroreflection shall be provided by a white band of construction grade reflective sheeting conforming to Subsection 719.01 150 mm [6 inches] wide, no more than 75 to 100 mm [3 to 4 inches] from the top of the cone and a 100 mm [4 inches] wide white band at least 50 mm [2 inches] below the 150 mm [6 inches] band.

Drums shall be of plastic or other yielding material and shall be approximately 900 mm [36 inches] high and a minimum of 450 mm [18 inches] in diameter. There shall be at least two reflectorized orange and at least two reflectorized white stripes at least 100 mm [4 inches] wide on each drum. Metal drums shall not be used.

Warning lights and battery operated flashing and steady burn lights shall conform to the requirements Subsection 712.23.

Type I barricades shall be 600 mm minimum, 2400 mm maximum [2 feet minimum, 8 feet maximum] in length with a 200 mm [8 inch] wide rail mounted 900 mm [3 feet] minimum above the ground. Type II barricades shall be 600 mm [2 feet] in length with two 200 mm [8 inch] wide rails, the top rail shall be mounted 900 mm [3 feet] maximum above the roadway. Type III barricades shall be 2400 mm [8 feet] in length with three 200 mm [8 inch] wide rails, the top rail shall be mounted 1500 mm [5 feet] minimum above the roadway.

The cross members of all barricades shall be of 13 mm [1/2 inch] or 16 mm [5/8 inch] thick plywood conforming to the requirements of Subsection 652.02 or other lightweight rigid material such as plastic, fiberglass or fiberwood as approved by the Engineer. The predominant color for supports and other barricades components shall be white, except that unpainted galvanized metal or aluminum components may be used.

CONSTRUCTION REQUIREMENTS

652.06 General. Prior to starting any work on any part of the project adjacent to or being used by the traveling public, the Contractor shall install the appropriate traffic control devices in accordance with the plans, specifications and the latest edition of Manual of Uniform Traffic Control Devices, Part VI. The Contractor shall continuously maintain the traffic control devices in their proper position, clean, legible and in good repair throughout the duration of the work. If notified that the traffic control devices are not in place or not properly maintained, the Contractor may be ordered to immediately suspend work until all deficiencies are corrected.

No equipment or vehicles of the Contractor, his subcontractors or employees engaged in work on this contract shall be parked or stopped on lanes carrying traffic, or on lanes or shoulders adjacent to lanes carrying traffic, at any time, except as required by ongoing work operations.

All excavation areas adjacent to the roadway shall be channelized by vertical panel markers, barricades, drums, cones, as shown on the plans or as directed. Channelization shall be continuous in both directions for the length of the project in all areas where the centerline strip is not effective.

Where the roadway is adjacent to an area being excavated, a minimum 600 mm [2 foot] shoulder should be maintained and the effective slope of the earth excavation beyond the 600 mm [2 foot] shoulder shall not be steeper than a 1½ horizontal to 1 vertical. The effective slope of rock excavation shall not be steeper than 1 horizontal to 1 vertical beyond the 600 mm [2 foot] shoulder. In the case of cuts over 1.5 m [5 feet deep, an earth berm or other approved barrier shall be placed between the travel lane and the excavated area. In this instance, travel speeds shall be limited by specific advisory signing to 20 miles per hour in all cases. When excavation does not leave sufficient usable widths to maintain two way traffic as provided in Section 104.04, one lane traffic controlled by a traffic signal or continuous flagging may be considered.

652.07 Installation of Traffic Control Devices. Easel mounted signs shall be erected so that the bottom of the sign is a minimum of 900 mm [3 feet] above the travelled way. Post mounted signs shall be erected so the bottom of the sign is between 1500 mm [5 feet] and 2100 mm [7 feet] above the travel way. Signs may be mounted lower or higher to fit the situation when authorized. Cones shall be either weighted or nailed. Tires will not be allowed.

Vertical panel markers shall be mounted with the top at least 1200 mm [4 feet] above the traveled way.

Drums shall not be weighted on the top. Drain holes shall be provided to prevent water from accumulating in the drums. Drums may be weighted with loose dry sand.

The Contractor shall operate and maintain the flashing arrow board unit and trailer and shall continuously supply fuel and lubrication for dependable service during the life of the contract. The units shall remain in continuous night and day service at locations designated until such time as the Engineer designates a new location or discontinuance of service.

The Contractor shall maintain the devices in proper position and clean them as necessary.

The Contractor shall replace damaged traffic control devices with devices of equal quality, as directed.

652.08 Traffic Control. The Contractor shall provide a roadway width as specified or as directed. Vertical panel markers, drums, cones or striping shall be used to clearly delineate the roadway through the construction area as directed.

The traffic control devices shall be moved or removed as the work progresses to assure compatibility between the use of the traffic control devices and the traffic flow. Traffic control devices which become unnecessary shall be immediately removed from use.

Pavement markings shall be altered as required to conform to the existing traffic flow pattern. Repainting of lines, under temporary 100 mm [4 inch] pavement marking line, if required to maintain the effectiveness of the line, shall be considered to be maintenance of traffic control devices, no separate payment will be made.

Inappropriate existing pavement markings shall be removed whenever traffic is rerouted and temporary construction pavement markings shall be placed. Traffic changes shall not be made unless there is sufficient time, equipment, materials and personnel available to complete the change properly before the end of the workday. This provision will not be required when traffic is rerouted for brief periods during daylight hours and the route can be clearly defined by channelizing devices or flaggers or both.

652.09 Flaggers. When specified, the Contractor shall furnish flaggers. Flaggers shall receive annual training consisting of class and video instruction. Courses will be reviewed by the Department.

Orange clothing, such as a vest, shirt or jacket and hard hat shall be furnished for and worn by flaggers. For nighttime conditions similar outside garments shall be reflectorized and lighted hand signal devices shall be used.

Only signals which conform to the latest revision of the Manual of Uniform Traffic Control Devices, Part VI, may be used.

While flagging, the flagger should stand either on the shoulder adjacent to the traffic being controlled or in the barricaded lane. At a spot obstruction, the flagger may stand on the shoulder opposite the barricaded sections to operate effectively. Under no circumstances shall the flagger stand in the lane being used by moving traffic. The flagger should be clearly visible to approaching traffic at all times and should stand alone.

When conditions do not allow for proper approach sight distance of a flagger or storage space for waiting vehicles, additional flaggers shall be used at the rear of the backlogged traffic or at a point where approaching vehicles have adequate stopping sight distance to the rear of the backlogged traffic.

Flaggers shall be provided 10 minute breaks every two hours and a lunch period away from the work station. The Contractor shall furnish sufficient spare trained flaggers to provide continuous flagging during required or necessary breaks and during lunch periods.

652.10 Warning Lights. Warning lights shall be installed at locations designated prior to any work being done on the portions of roadway being used by traffic. Upon installation, all warning lights shall remain in continuous operation during the life of the project, unless otherwise authorized.

When a suitable 120 volt AC power service source is available within 150 m [500 feet] of the designated warning light location, power operated flashing lights shall be installed. Two alternately flashing lamps, shall be mounted approximately 600 mm [24 inches] above the sign spaced approximately 600 mm [24 inches] apart.

When a suitable 120 volt AC power service source is not available, battery operated flashing lights may be erected. Four flashing lamps shall be mounted approximately 150 mm [6 inches] above the sign spaced approximately 300 mm [12 inches] apart.

The power service connections shall be installed to the satisfaction of both the power company and the Engineer. The Contractor shall make all necessary arrangements for the power service connections and be responsible for all charges incurred thereby, including power charges. The Contractor shall also be responsible for all outstanding bills from the electric power company for preliminary work done by the electric company for the power service connection.

When batteries are required for battery operated flashing lights, they shall be provided by the Contractor as necessary.

652.11 through 652.14 Vacant

652.15 Method of Measurement. Signs and panel markers will be measured by the square meter [square foot] for all signs authorized and installed.

Flashing arrow boards, and flashing and steady burn lights, will be measured by each unit authorized and installed on the project. Barricades, drums and cones will be measured by each unit authorized.

The accepted quantity of flagger time will be measured for payment by the number of hours measured to the nearest 1/4 hour. It will include time spent actually flagging, including breaks, and

also the hours that necessary spare flaggers are on the project. The number of spare flaggers will be as determined by the Engineer. Lunch periods will not be included for measurement.

Maintenance of traffic control devices will be measured by the calendar day or as one lump sum for all authorized and installed traffic control devices.

Warning lights will be measured by the group of lights furnished.

652.16 Basis of Payment. The accepted quantity of signs and panel markers will be paid for at the contract unit price per square meter [square foot]. Such payment will be full compensation for furnishing and installing all signs, sign supports and all incidentals necessary to complete the installation of the signs.

The accepted quantity of flashing arrow boards, barricades, battery operated flashing and steady burn lights, drums and cones will be paid for at the contract unit price each for the actual number of devices authorized, furnished and installed. Such payment shall be full compensation for all incidentals necessary to install the respective devices.

Maintenance of traffic control devices will be paid for by one of the following methods in accordance with the pay item included in the contract.

- (a) Maintenance of traffic control devices will be paid for at the contract unit price per calendar day for each calendar day that the Contractor maintains traffic as specified herein. Such payment will be full compensation for moving as many times as necessary, for replacing devices damaged, lost or stolen, and for cleaning, maintaining and removing all devices used for traffic control, including replacing temporary pavement marking lines.

The contract unit price per calendar day for maintenance of traffic control devices shall be full payment each day for such maintenance encompassing all areas of the contract regardless of whether the work areas or projects are geographically separated or not.

- (b) Maintenance of traffic control devices will be paid for at the contract lump sum price. Such payment will be full compensation for all days the Contractor maintains traffic as specified herein and for moving as many times as necessary, for replacing devices damaged, lost or stolen, and for cleaning, maintaining and removing all devices used for traffic control, including replacing temporary pavement marking lines.

The contract lump sum price for maintenance of traffic control devices shall be full compensation for all days for such maintenance encompassing all areas of the contract regardless of whether the work areas or projects are geographically separated or not separated.

The accepted quantities of flaggers will be paid for at the contract unit price per man hour with no additional payment for overtime. The contract unit price shall be full compensation for hiring, transporting, equipping, supervising and the payment of flaggers and all overhead and incidentals necessary to complete the work.

The accepted quantities of warning lights will be paid for at the contract unit price per group complete in place including the necessary power and remaining in operation during active work of the project or as otherwise directed. Upon completion of the work, the lamps, fixtures and the framework required to properly mount the lamps shall remain the property of the Contractor.

Payment for temporary construction pavement marking lines and pavement marking removal will be made under the respective pay item in Section 627 -- Pavement Markings.

Payment for temporary traffic signals will be made under Section 643 -- Traffic Signals.

There will be no payment made under the pay items in Section 652 for devices furnished or maintenance work required after the expiration of the adjusted total contract time.

Payment will be made under:

Pay Item	Pay Unit
652.30 Flashing Arrow	Each
652.31 Type I Barricade	Each
652.311 Type II Barricade	Each
652.312 Type III Barricades	Each
652.32 Battery Operated Light	Each
652.33 Drum	Each
652.34 Cone	Each
652.35 Construction Signs	square meter [Square Foot]
652.36 Maintenance of Traffic Control Devices	Calendar Day
652.361 Maintenance of Traffic Control Devices	Lump Sum
652.37 Warning Lights	Group
652.38 Flaggers	Man Hours

SECTION 653 -- POLYSTYRENE PLASTIC INSULATION

653.01 Description. This work shall consist of furnishing and installing a polystyrene plastic insulating layer at locations designated on the plans in accordance with these specifications.

MATERIALS

653.02 General. Insulating material shall be extruded polystyrene insulating board conforming to the requirements of AASHTO M230.

Pegs shall be hard wood, approximately 150 mm by 6 mm [6 inches by 1/4 inch] round, pointed on one end.

CONSTRUCTION REQUIREMENTS

653.03 Preparation of Foundation. The insulating boards shall be placed on a compacted layer of granular material graded to a tolerance of 13 mm [1/2 inch] above or below the required grade and cross section. The surface shall be free of rocks which would cause damage to the insulating boards. The type and thickness of the granular material will be as shown on the plans.

653.04 Placing Insulating Boards. The insulating boards shall be secured to the ground with pegs placed at each corner or where directed by the Engineer, and driven flush with the surface of the insulating board. Joints between the insulating boards shall be staggered. The openings in all joint shall be kept to a minimum.

653.05 Placing Backfill. After the insulating boards have been placed, granular material shall be placed using care to avoid pushing or puncturing the boards. The depth of the first layer of aggregate subbase sand shall not be less than 150 mm [6 inches] loose measure. The aggregate subbase sand shall be spread with a crawler type bulldozer of not more than 390 kg/m² [80 pounds per square foot] ground contact pressure or with other approved equipment but not supported directly on the insulating boards. Trucks and other heavy construction equipment shall not be operated directly on the insulating boards. The type and thickness of granular material will be shown on the plans.

653.06 Compaction. Compaction of the first layer of aggregate subbase sand shall be by vibratory methods to the satisfaction of the Engineer. After the first layer has been compacted, normal construction practices may be followed providing no loads are placed on the area which produce more than 390 kg/m² [80 pound per square foot] ground contact pressure.

653.07 Protection of Polystyrene. Since gasoline, oil, heat and sunlight will damage polystyrene, all precautions shall be taken to prevent them from damaging the insulating board. The insulating boards shall not be stored in sunlight for more than one day.

653.08 Method of Measurement. Polystyrene plastic insulation will be measured by the square meter [square yard] in place.

653.09 Basis of Payment. The accepted quantities of polystyrene plastic insulation will be paid for at the contract unit price per square meter [square yard] complete in place. Payment shall be full compensation for and for furnishing and placing the insulating boards of pegs.

Payment will be made under:

Pay Item - Metric Units	Pay Unit
653.20 25 mm Polystyrene Plastic Insulation	square meter
653.21 38 mm Polystyrene Plastic Insulation	square meter
653.22 50 mm Polystyrene Plastic Insulation	square meter
653.23 75 mm Polystyrene Plastic Insulation	square meter

Pay Item - English Units	Pay Unit

653.20	1 inch Polystyrene Plastic Insulation	Square Yard
653.21	1½ inch Polystyrene Plastic Insulation	Square Yard
653.22	2 inch Polystyrene Plastic Insulation	Square Yard
653.23	3 inch Polystyrene Plastic Insulation	Square Yard

SECTION 654 -- VACANT

SECTION 655 -- ELECTRICAL WORK

Reserved

SECTION 656 -- TEMPORARY EROSION CONTROL

656.01 Description. This work shall consist of providing temporary erosion control during construction in accordance with these specifications, standard details, or as otherwise directed.

MATERIALS

656.02 General. Baled hay shall be bales at approximately 350 by 450 by 750 mm [14 by 18 by 30 inches], or equivalent, securely tied to form a firm bale.

Sandbags shall consist of heavy cloth or woven plastic bags, approximately 0.03 m³ [1 cubic foot] capacity, filled with sand or gravel.

Dumped stone shall be a graded mixture of large and small stone with approximately 50 percent of the stones larger than 150 mm [6 inches].

Flexible drainage pipe shall consist of collapsible neoprene pipe or approved equal, with a minimum diameter of 200 mm [8 inches].

656.03 Silt Fence.

(a) Posts. Either hardwood posts or steel posts shall be used.

Hardwood posts shall be straight, at least 450 mm [18 inches] longer than the height of the silt fence and at least 32 mm by 32 mm [1¼ inch by 1¼ inch].

Staples shall be of No. 9 wire.

Steel posts shall be at least 450 mm [18 inches] longer than the height of the silt fence and have the means provided for fastening wire to the fence.

(b) Wire Support Fence, if required, shall be at least 50 mm [2 inches] higher than the height of the silt fence. Horizontal and vertical wires shall be spaced no more than

150 mm [6 inches] apart. The top and bottom wires shall be at least 10 gauge; all other wires at least 12 gauge.

- (c) Silt Fence. The woven geotextile fabric and components shall be made from polypropylene, polyester, polyamide or other chemically stable material and be resistant to ultraviolet radiation degradation for at least 12 months of installation. Silt retention capacity shall be no less than 75 percent. The fabric shall have a Mullen burst test of no less than 1790 kPa [260 pounds per square inch] with a maximum average sieve opening size of 850 μ m to 250 μ m [No. 20 to No. 60]. Roll width of the fabric shall be no less than 150 mm [6 inches] wider than the height of the fence, except fabric for boom supported floating silt fence which shall be no less than 600 mm [2 feet] wider than the design width.
- (d) Flotation devices. The flotation boom and weighing devices for boom supported floating silt fence shall be sufficient to hold the fence in an approximately vertical position.

CONSTRUCTION REQUIREMENTS

656.04 Temporary Erosion Checks. Temporary erosion checks shall be constructed in ditches and at other locations designated. Checks shall be in accordance with the Standard Detail unless otherwise directed.

Baled hay, sandbags or both, shall be used in other areas as necessary to inhibit soil erosion.

656.05 Temporary Berms. When designated, temporary barriers shall be constructed along the edge of the embankment. The barriers shall be of embankment earth material, gravel or sand as available and shaped approximately as shown in the Standard Details. The barriers shall be compacted with the wheels of construction equipment.

At designated intervals, temporary slope drains shall be constructed with a crescent shaped barrier placed at each slope drain to direct the water into the inlet pipe.

656.06 Temporary Slope Drains. Collapsible pipe with corrugated metal pipe inlet shall be placed down the embankment slopes at designated locations and in accordance with the Standard Details.

At the outlet end of the drain, dumped stone shall be placed, to prevent scoring unless otherwise directed.

656.07 Dumped Stone. Dumped stone shall be placed at designated locations and shaped to the extent necessary to spread the stone over the area and in sufficient depth to prevent soil erosion.

656.08 Silt Fence. The silt fence shall be installed at all environmentally sensitive areas as shown on the plans or as directed. The Contractor shall have the option to provide a reinforced filter fabric or an unreinforced filter fabric attached to a wire fence.

The fence posts shall be spaced as specified by the Engineer, however, not to exceed a maximum of 2.5 m [8 feet] apart when either type of silt fence is used and be driven a minimum of 450 mm [18 inches] into the ground.

The geotextile fabric shall be secured to the post or fence by suitable staples, tie wire or hog rings in such a manner as to prevent tearing and sagging of the fabric. The bottom of the geotextile fabric shall be entrenched into the ground a minimum depth of 150 mm [6 inches] to prevent water from flowing under the fence. The geotextile shall be spliced together only at support posts with a minimum 150 mm [6 inch] overlap and secure post connection which prevents leakage of silt. The top of the geotextile shall be installed with a reinforced top end section.

The Contractor shall maintain the silt fence in a functional condition at all times. It shall be inspected after each rainfall and at least daily during prolonged rainfall. All deficiencies shall be immediately corrected by the Contractor. The Contractor shall make a daily inspection of the silt fences in areas where construction activity causes drainage runoff, to ensure that the silt fences are properly located for effectiveness. Where deficiencies exist, additional silt fences shall be installed as approved or directed.

Sediment deposits shall be removed when directed. All sediment deposits remaining in place after the device is no longer required shall be graded to conform with the existing ground, seeded and mulched immediately.

Geotextile fabric which has decomposed or has become ineffective and is still needed shall be replaced with material equal to the original design.

656.081 Boom Supported Floating Silt Fence. The silt fence fabric shall be securely attached to the flotation boom with a continuous weight placed the entire length of the fence to maintain the fence in a vertical submerged position from the surface of the water to the design depth.

Anchor's shall be placed at the ends of the fence, and intermediate locations if necessary, to hold the fence securely in place.

656.082 Maintenance. All temporary erosion control measures shall be inspected at least weekly, and more often if necessary, to assure continuous effectiveness. All deficiencies shall be corrected immediately by the Contractor. Maintenance during periods of suspension and until a growth of grass is obtained shall be as specified in subsection 107.26.

656.09 Removing and Disposing. When no longer needed, material and devices for temporary erosion control shall be removed or may be left in place and dispersed over an adjacent area, as directed.

When removed, such devices may be reused in other locations provided they are in good condition and suitable to perform the erosion control for which they are intended.

When dispersed over adjacent areas, the material shall be scattered to the extent that it causes no unsightly conditions nor creates future maintenance problems. Dumped stone shall be dispersed or covered in such a manner that it will not interfere with future mowing operations.

656.10 Method of Measurement. Baled hay and sandbags will be measured for payment by the number of bales or bags satisfactorily placed. Dumped stone will be measured for payment by the cubic meter [cubic yard] in vehicles in accordance with the requirements of Section 109 -- Measurement and Payment.

Temporary berms and temporary slope drains will be measured for payment by the meter [linear foot] measured parallel with the flow line including the pipe inlet.

Temporary silt fence will be measured by the meter [linear foot] along the gradient of the fence, end post to end post.

Boom supported floating silt fence will be measured by the meter [linear foot] not including anchorages.

656.11 Basis of Payment. The accepted quantity of baled hay or sandbags will be paid for at the contract unit price each for each bale or bag which price shall be full compensation for furnishing and placing the bales or sandbags, for furnishing and driving the stakes for baled hay and for the removing and disposing of the bales, stakes and sandbags when no longer needed.

The accepted quantity of temporary berms will be paid for at the contract unit price per meter [linear foot] of berm which price shall be full compensation for furnishing, placing and compacting material, for maintaining and for removing the berm when no longer needed.

There will be no separate payment for excavation done in the construction of temporary erosion control items under this section and all necessary excavation shall be considered incidental to the work.

The accepted quantity of dumped stone will be paid for at the contract unit price per cubic meter [cubic yard] which price shall be full compensation for furnishing the stone, transporting, placing and shaping. Payment for removal or for covering will be made under Item 629.05 Hand Labor and the appropriate equipment rental items.

The accepted quantity of temporary silt fence and boom supported floating silt fence will be paid for at the contract unit price per meter [linear foot] complete in place. Payment shall be full compensation for furnishing, installing, maintaining, for replacing deteriorated geotextile and clogged geotextile when required and for removing and disposing of the fence when no longer needed.

The removal of sediments and debris that accumulate around erosion control devices, when directed by the Engineer, will be paid for under the appropriate contract items.

Cost of seeding and mulching the area after removal of the temporary wilt fence will be paid for at the contract unit prices for Item 618 -- Seeding and Item 619 -- Mulch.

Payment will be made under:

Pay Item	Pay Unit
656.50 Baled Hay, in place	Each

656.51	Sandbag, in place	Each
656.55	Dumped Stone	cubic meter [Cubic Yard]
656.60	Temporary Berms	meter [Linear Foot]
656.62	Temporary Slope Drains	meter [Linear Foot]
656.631	375 mm [15"] Temporary Silt Fence	meter [Linear Foot]
656.632	750 mm [30"] Temporary Silt Fence	meter [Linear Foot]
656.64	Boom Supported Floating Silt Fence	meter [Linear Foot]

SECTION 657 -- REHABILITATION OF PITS

657.01 Description. This work shall consist of grading and treating the surface of pit areas in accordance with these specifications and as directed.

MATERIALS

657.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Fertilizer	717.01
Agricultural Ground Limestone	717.02
Seed	717.03

Seed shall be in accordance with the provisions for Method No. 2. When used for the rehabilitation of areas except loam and sod fields, the following seed shall be added to each 45 kg [100 pounds] of the seed mixture: 2 kg [5 pounds] of Orchard Grass, 2 kg [5 pounds] of Reed Canary Grass, 2 kg [5 pounds] of Ladino Clover and 4.5 kg [10 pounds] of Sweet Clover.

CONSTRUCTION REQUIREMENTS

657.03 Grading. Upon the completion of excavating the pit, the Contractor shall grade the pit area compatible with the surroundings. Strippings shall be redistributed over the pit area as directed.

The area where granular material is exposed shall be graded to a slope of 1 vertical to 1 horizontal or flatter. The areas of all non-granular slopes shall be graded to a slope of 1 vertical to 2 horizontal or flatter. Tree stumps, roots and other debris shall be covered. The areas of pits of solid or broken ledge rock shall be trimmed of loose rock and the bottom of the pit graded to be compatible with the surroundings.

Wherever ponds are left within the pit, a slope of 1 vertical to 4 horizontal to or flatter, shall extend into the water at least 5 m [16 feet] to assure that the pond will not be a hazard to the public.

657.04 Surface Treatment. After completion of the grading and distribution of the strippings, the ground surface shall be fertilized and seeded as directed.

Fertilizing and seeding shall be done in accordance with the procedures of Section 618, Method Number 2 except for the added seed mixture to be used when required. The seed shall be applied at the rate of 1.5 kg [3 pounds] of seed mixture per unit.

Mulching shall be applied in accordance with Section 619 -- Mulch.

657.05 Method of Measurement. Seeding pits will be measured by the 100 m² [1,000 square foot] unit of land seeded, measured along the slope of the ground from the extremities of seeded area, except as noted in Subsection 657.06.

657.06 Basis of Payment. The accepted quantity of seeding pits will be paid for at the contract price per unit which price shall be full compensation for furnishing and applying agricultural ground limestone, fertilizer and the designated type seed at the specified rate, and for tilling the soil to implant the seed.

Cost of grading of slopes and bottoms of pits, grading of stripping piles over the pit and grading of all other pit areas distributed by the Contractor under this project shall be considered incidental to the various contract items and no additional payment will be made.

Mulching, when called for, will be paid for under Section 619 -- Mulch.

When the bid schedule does not contain an estimated quantity for Seeding Pits, the work, equipment and materials required to meet the requirements of Section 657 -- Rehabilitation of Pits and Section 619 -- Mulch will not be paid for directly but will be considered incidental to the other contract items.

Payment will be made under:

Pay Item	Pay Unit
657.24 Seeding	Unit

SECTION 658 -- ACRYLIC LATEX COLOR FINISH

Reserved

SECTION 659 -- MOBILIZATION

659.01 Description. When this item is listed as a Pay Item in the Proposal, it shall consist of preparatory work and operations including, but not limited to those necessary to the movement of personnel, equipment, supplies and incidentals to the project site; and for all other work and

operations which must be performed or costs incurred prior to beginning work on the various items on the project site.

PAYMENT

659.02 Basis of Payment. Partial payments will be made as follows:

- (a) When the Contract is executed, 1 percent of the original contract amount less the amount bid for Mobilization, not to exceed the contract amount for Mobilization, will be paid.
- (b) When 5 percent of the original contract amount is earned, 30 percent of the amount bid for Mobilization or 3 percent of the original contract amount less the amount bid for Mobilization, whichever is lesser, but not less than the amount previously paid under (a), will be paid.
- (c) When 10 percent of the original Contract amount is earned, 55 percent of the amount bid for Mobilization or 5.5 percent of the original contract amount less the amount bid for Mobilization, whichever is lesser, but not less than the amount previously paid under (a), will be paid.
- (d) When 25 percent of the original contract amount is earned, 65 percent of the amount bid for Mobilization or 6.5 percent of the original contract amount less the amount bid for Mobilization, whichever is lesser, but not less than the amount previously paid under (a), will be paid.
- (e) When 50 percent of the original contract amount is earned, 100 percent of the amount bid for Mobilization or 10 percent of the original contract amount less the amount bid for Mobilization, whichever is lesser, will be paid.
- (f) Upon completion of all work on the Project, payment of any amount bid for Mobilization in excess of 10 percent of the original contract amount, will be paid.
- (g) The total sum of payments under this item shall not exceed the original contract amount bid regardless of the fact that the Contractor may shut down his work on the project or move equipment away from the project and then back again.

Payment will be made under:

Pay Item	Pay Unit
659.10 Mobilization	Lump Sum

SECTION 660 -- ON-THE-JOB TRAINING

Reserved

SECTION 661 -- VACANT

SECTION 700 -- MATERIALS

GENERAL STATEMENT

For all materials used in the work for which there is no specified testing by the project Inspectors or the Laboratory, the Contractor shall submit a Materials Certification Letter similar to the following, prior to acceptance as specified in Subsection 109.10:

Company Letterhead

Mr. _____, Resident Date _____

Address _____ Project No. _____

Town _____

"This is to certify that the below listed materials, which were incorporated into the above designated project, comply with the pertinent specified material requirements of the contract. Processing, project testing and inspection control of raw materials are in conformity with the applicable drawings and/or standards of all articles furnished." (List only those items used on this contract.)

Bridge Railing and Hardware
Castings, Grates, Frames & Traps
Concrete Blocks, Bricks, Curb, & Precast Sections
Culverts, Underdrain, Metal Sluices, Structural Plate Pipe,
& Structural Plate Arches
Elastomeric Expansion Devices
Electrical Conduit
Epoxy Resin Surface Sealant
Erosion Control Mesh
Fencing; Posts, Fabric & Hardware
Field Painting (Paint only)
Foundation Piles
Gabions
Guard Rail, including Rail, Posts, Cable, Beams, Anchor
Rods, Brackets, Bolts and Fittings
Joint Sealant
Luminaires & Supports
Membrane Waterproofing
Modular Expansion Devices
Polyvinylchloride Waterstops
Preformed Elastic Joint Seal
Pressure Treated Posts
Reinforced Earth Wall
Reinforcing Steel
Seed

Shear Connectors
Signs and Sign Supports
Steel Pipe Railings
Steel Shells
Traffic Signals, Equipment & Supports

The Contractor may be required to submit to the Engineer, for inclusion in the project records, certification and other data from the Manufacturer pertaining to materials used on the project.

"All records and documents pertinent to this letter and not submitted herewith will be maintained available by the undersigned for a period of not less than 3 years from the date of completion of the project."

The Materials Certification letter must be signed by a person having legal authority to bind the Contractor.

Materials listed in the above Certificate may be subject to random sampling and testing by the Department. Certified materials which fail to meet specification requirement may not be accepted.

For Bituminous Material, the Contractor shall arrange for the Supplier to furnish a CERTIFICATE OF ANALYSIS for all bituminous liquids and cements furnished for use on the project. The Certificate shall include the actual test results of the material in storage from which the shipments are being made. Certificates shall be supplied for each lot, batch or blend of each type and grade of material. A new certificate shall be issued at least every 30 days or upon receiving or manufacture of a new material. The original of each Certificate of Analysis shall be mailed to the Engineer of Technical Services, Maine Department of Transportation, State House Sta. 16, Augusta, Maine 04333-0016.

The Contractor shall give the supplier sufficient advance notice of orders to permit testing. Material not represented by tests will not be accepted for use on the work.

Deliveries of bituminous liquids and cements shall be accompanied by a loading invoice, delivery ticket or slip, as required under Subsection 109.01(f). The Loading Invoice shall include the applicable certificate number and shall include a printed or stamped statement such as the following:

"THIS IS TO CERTIFY THAT THE BITUMINOUS MATERIAL REPRESENTED BY THIS LOADING INVOICE CONFORMS TO THE SPECIFICATIONS OF THE PURCHASER FOR THE MATERIAL TYPE AND GRADE STATED THEREON."

When automatic line-blending equipment is used, a Certification of Analysis as required above shall be furnished or referred to for each component material incorporated into the product. The proportion of each component and its respective Certificate Number shall be shown on the Loading Invoice.

In the event an intermediate hauler of the bituminous material is involved, he shall furnish a copy of his own delivery slip, as well as a copy of the supplier's loading invoice. The hauler's delivery slip and the supplier's loading invoice shall be cross-referenced by use of their respective serial numbers.

All test procedures shall conform to the requirements of AASHTO unless otherwise noted. Gradation tests shall be completed in accordance with AASHTO T27 except that the sample may be separated on the 12.5 mm [1/2 inch] screen and that the results of the material finer than the 75 m [Number 200] sieve shall be reported to the nearest 0.1 percent. Testing as specified in AASHTO T11 shall be performed on any materials for which there is a specification limit on the amount of material passing a 75 m [No. 200] sieve.

SECTION 701 -- STRUCTURAL CONCRETE RELATED MATERIAL

701.01 Portland Cement and Portland Pozzolan Cement. Portland cement shall conform to the requirements of AASHTO M85, Type II, with no requirement for tensile strength.

A Type II or Type III cement meeting AASHTO M85 may be used when making precast units.

A Type IP(MS) portland-pozzolan cement (blended hydraulic cement with moderate sulfate resistance) meeting the requirements of ASTM C595, may be used instead of Type II or where Type I portland cement, meeting the requirements of AASHTO M85, is allowed. The definitions of the two hydraulic cements mentioned above are as follows: (See ASTM C219)

Portland cement - a hydraulic cement produced by pulverizing portland cement clinker, and usually containing calcium sulfate.

Portland-pozzolan cement - a hydraulic cement consisting of an intimate and uniform blend of portland cement or portland blastfurnace slag cement and fine pozzolan produced by intergrinding portland cement clinker and pozzolan, by blending portland cement or portland blastfurnace slag cement and finely divided pozzolan, or a combination of intergrinding and blending, in which the amount of the pozzolan constituent is within specified limits.

Only one brand of cement shall be used on any one contract unless otherwise permitted, in writing, by the Engineer.

701.02 Water. Water used in mixing or curing concrete shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetation or substances injurious to the finished product. If

required by the Engineer, it shall be tested by comparison with water of known satisfactory quality. Comparison shall be made by means of standard cement tests for soundness, time of setting and mortar strength. Any indication of unsoundness, marked change in time of setting or a reduction of more than 10 percent in strength from results obtained with mixtures containing water of known satisfactory quality shall be sufficient cause for rejection of the water that is being tested. Water, known to be of potable quality may be used without testing. Where the source of water is relatively shallow, the intake shall be so enclosed as to exclude silt, mud, grass or other foreign materials.

701.03 Air-entraining Admixtures. Air-entraining admixtures shall be in accordance with the requirements of AASHTO M154 except that tests for requirements of 6.1.1. and 6.1.6. will not be required.

The materials used shall comply with one of the following requirements:

- (a) A material included in an approved list maintained by the Department. The Contractor may select any brand included in this list.
- (b) A material approved by the Testing Laboratory of the Department after examination of a recognized independent testing laboratory's documented test results of that material's performance. Acceptance will be dependent on a materials conformance to all sections of AASHTO M154 other than the above noted exceptions.

701.04 Water Reducing Admixtures. Water reducing admixtures shall conform to the requirements of AASHTO M194, Type A.

The materials used shall comply with the requirements of Subsection 701.041(a) and (b).

701.0401 High Range, Water Reducing, Admixture. High range, water reducing admixture, commonly referred to as both super-water-reducers and/or superplasticizers, shall conform to the requirements of AASHTO M194, Type F.

The material used shall comply with one of the following requirements:

- (a) A material included in an approved list maintained by the Department. The Contractor may select any brand included in this list.
- (b) A material approved by the Engineer of the Department after examination of a recognized independent testing laboratory's documented test results of that material's performance. Acceptance will be dependent on a material's conformance to all sections of AASHTO M194.

Test reports that are more than five (5) years old will not be considered acceptable.

The manufacturer of the superplasticizing admixture shall supply the Engineer with a set of slump loss curves for at least 3 different temperatures representative of the temperature range 10

to 29 °C [50 to 85 °F]. It is intended that the concrete mix temperature and the ambient temperature be nearly identical for each curve. It is not necessary that this data be representative of the proposed mix ingredients except that the amount of superplasticizing admixture and the cement content be close to that proposed.

701.05 Set-retarding Admixtures. Set-retarding admixtures shall conform to the requirements of AASHTO M194, Types B or D.

The materials used shall comply with the requirements of Subsection 701.041(a) and (b).

701.06 Curing Materials. Sheet materials for curing concrete shall conform to the requirements of AASHTO M171 (ASTM C171). Burlap cloth shall conform to the requirements of AASHTO M182. Liquid membrane-forming compounds shall conform to the requirements of AASHTO M148 (ASTM C309).

The liquid membrane-forming compound shall comply with the requirements of Subsection 701.03(a) and (b) except that the materials conformance will be to AASHTO M148. The two types of approved liquid membrane-forming compounds are: (1) Type 1-D, clear or translucent with fugitive dye which must be readily distinguishable for at least 4 hours and must be inconspicuous in 7 days and (2) Type 2, white pigmented.

701.07 Waterstops. Waterstops shall be polyvinylchloride and conform to the requirements of US Army Corps of Engineers Specification CRD C-572.

701.08 Heavy Roofing Felt. Wherever heavy roofing is called for on the plans an approved standard brand of asphalt saturated roofing felt, weighing about 27 kg/10 m² [55 pounds per 100 square feet] shall be used.

701.09 Vacant

701.10 Fly Ash. Fly ash shall conform to the chemical and physical requirements for mineral admixture, Class F and Class C, listed in ASTM C618 including Table 1A, except for Footnote A. Loss on ignition shall not exceed 4.0 percent. The use of fly ash produced by plants which utilize compounds of sodium, ammonium, or sulfur to control stack emissions shall not be used. Conformance will be assured by a program of testing, including quality control (QC) exercised by the fly ash supplier and quality assurance (QA) exercised by the Department. Initially any source or terminal locations from suppliers will receive acceptance based on testing performed by the supplier and also testing performed by the Department. After a satisfactory history of supply has been established, the fly ash supplier will be permitted to ship fly ash on certification based solely on his own quality control, with monitoring of the quality of fly ash by the Department.

Shipments of fly ash to concrete producing facilities shall have approval for use before arrival to that facility.

- (a) Source. The fly ash supplier's source shall receive acceptance based on forwarding detailed information on the following:

1. Source of coal and type burned.
2. Plant burning process, type of boiler and boiler operation.
3. Fly ash recovery process and type of collection equipment.
4. Fly ash properties and past variability.
5. Fly ash storage facilities.
6. Frequency and adequacy of the quality control program of the fly ash supplier.
7. Sample test results by fly ash supplier's own testing facility, if available.
8. Sample test results from the fly ash supplier by a certified, independent testing laboratory approved by the Engineer.
9. Testing data received on a sample split with the Department where comparison will be evaluated from triplicate testing by the supplier and also triplicate testing by the Department for each sample half.

(b) Acceptance. The acceptance will be based on an evaluation by the Department in accordance with the following:

1. Comparative testing of a sample split between the supplier and the Department, certified independent testing lab results and other fly ash testing results made by the supplier, if available.
2. Evaluation of testing equipment, methods employed and techniques of testing.
3. Inspection of fly ash supplier's facility.

(c) Supplier Quality Control Procedures. The quality control procedures employed by the supplier (QC) shall be such that only fly ash conforming to this subsection is presented to the Department for acceptance consideration.

The testing shall be at the frequency specified by ASTM C311, except as modified herein. Additionally, the fly ash supplier shall test a representative portion of each sample obtained by the Department for acceptance consideration for loss on ignition and for fineness.

(d) Department Quality Approval Procedures. The Department may establish an Approved List of suppliers of Fly Ash through an intensive evaluation of the supplier's quality control program.

Initially, fly ash will be considered for acceptance for the minimum sampling and testing frequencies established in ASTM C311 of both the supplier's testing (QC) and sampling and testing by the Department (QA). Representative samples will be obtained by the Department at the source or terminal location.

A 4 L [one gallon] size sample in a moisture proof container will be taken by an authorized representative of the Department at the beginning of the project.

Additional similar 1 L [one quart] samples will be taken daily representing concrete placed that day.

All samples shall be identified and will be submitted to the Department's Central Laboratory.

These samples will be tested by the Department for loss on ignition and for fineness. The Department reserves the right to test these samples for all specified properties to determine acceptability.

The effectiveness of the supplier's QC program will be continually monitored by the Department by periodically sampling at the source or at the supplier's facility as well as sampling at supplier's destination.

701.11 Calcium Nitrite Solution. Calcium nitrite solutions shall conform to the requirements of AASHTO M194, Type C (accelerating admixtures). An approved calcium nitrite based corrosion inhibitor shall be added to the concrete mix as an aqueous solution. (Calcium nitrite in concrete mixes inhibits the corrosion of steel reinforcement and/or steel plate in concrete sections; calcium nitrite also accelerates the strength gain of concrete mixes).

The material shall be approved by the Testing Laboratory of the Department after examination of certified test results of the material's performance. Acceptance will be dependent on the material's conformance to all sections of AASHTO M194. Test reports that are more than 5 years old will not be acceptable.

701.12 Silica Fume. The silica fume material for use in Portland Cement Concrete shall be one of the products listed on the Maine Department of Transportation's list of prequalified silica fume (microsilica) admixtures.

SECTION 702 -- BITUMINOUS MATERIAL

702.01 Asphalt Cement. Asphalt cement shall conform to the requirements of Table 2 of AASHTO M226 for Viscosity Graded Asphalt Cement, except that the Spot Test will not be required and Table 2 is modified to read as follows:

TEST			VISCOSITY GRADE	
	AC-2.5	AC - 5	AC - 10	AC - 20
VISCOSITY, 60 °C [140 °F], poises	250 ± 50	500 ±100	1000 ± 200	2000 ± 400
VISCOSITY, 135 °C	125+	175+	250+	300+
PENETRATION, 25 °C [77 °F], 100 G 5 S 0.1 mm	220+	140+	80+	60+
FLASH POINT, COC, °C	163+	177+	219+	232+
°F	[325+]	[350+]	[425+]	[450+]
THIN-FILM OVEN TEST				
LOSS ON HEARING, % BY WEIGHT	--	1.0-	0.5-	0.5-
TEST ON RESIDUE				
VISCOSITY, 60 °C [140 °F], poises	1000-	2000-	4000-	8000-
DUCTILITY, 25 °C [77 °F], 5 cm per min cm	100+	100+	75+	50+
Note: If ductility is less than 100 at 25 °C [77°F], the asphalt cement will be acceptable if the ductility is 100 or more at	15.6 °C [60 °F]			

702.02 Vacant

702.03 Cut-Back Asphalts. Cut-back asphalts shall conform to AASHTO M82, Cut-Back Asphalt (Medium Curing Type), except that the Spot Test will not be required and Table 1 is modified to read as follows:

GRADE	MC-30	MC-70	MC-250	MC-800	MC-3000
TEST					
KINEMATIC VISCOSITY AT 60 °C [140 °F], 10-6M ² /SEC	30 - 60	70 - 140	250 - 500	800-1600	3000-6000
[centistokes]					
FLASH POINT (TAGE, OPEN-CUP) °C	38+	38+	66+	66+	66+
°F	[100+]	[100+]	[150+]	[150+]	[150+]
WATER, %	0.2-	0.2-	0.2-	0.2-	0.2-
DISTILLATION TEST:					
DISTILLATE % BY VOLUME OF TOTAL DISTILLATE					
TO 360 °C [680 °F]					
TO 225 °C [437 °F]	0-25	0-20	0-10	**	**
TO 260 °C [500°F]	40-70	20-60	15-55	0-35	0-15
TO 315 °C [600°F]	75-93	65-90	60-87	45-80	15-75
RESIDUE FROM DISTILLATION TO 360 °C [680°F], VOLUME					
PERCENTAGE OF SAMPLE BY DIFFERENCE	50+	55+	67+	75+	80+
TEST ON RESIDUE FROM DISTILLATION, ALL GRADE:					
ABSOLUTE VISCOSITY AT 60°C [140 °F], 10-1P S POISES			300-1200		
DUCTILITY, 5 cm/min at 25°C [77 °F], cm (See Note)			100+		

Note: If less than 100, the material will be acceptable if the ductility at 15.6 °C [60 °F] is over 100.

* This table is a portion of AASHTO M82-75 (1982). Table 1.

702.04 Emulsified Asphalt. Emulsified asphalt shall conform to AASHTO M140, except that Table 1 is modified to read as follows:

ME DOT Table 1 (702.04) ANIONIC EMULSIFIED ASPHALT

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TYPE	RAPID-	SETTING			MEDIUM	-	SETTING					SLOW-	SETTING
GRADE	RS-1	RS-2	MS-1	MS-2	MS-2h	HFMS-1	HFMS-2	HFMS-2h	HFMS-2e	MS-4	MS-5	SS-1	SS-1h
VISCOSITY, S.S.F.													
AT 25°C [77°F], seconds	20-100	---	20-100	100+(a)	100+(a)	20-100	30+(A)	30+(A)	50+(A)	20-500	20-500	20-100	20-100
(See Note A)													
AT 50°C [122°F], seconds	---	75-400	---	---	---	---	---	---	---	---	---	---	---
STORAGE STABILITY, 24 H %	1-	1-	1-	1-	1-		1-	1-	1-	1-	1-	1-	1-
(See Note G)													
DEMULSIBILITY,													
35 ml 0.02 N CO-Cl ₂ . %	60+	60+	---	---	---	---	---	---	---	---	---	---	---
COATING ABILITY & WATER													
RESISTANCE (See Notes)	---	---	B	B	B	B, D	B, E	B, E	B	C	C, E	---	---
SIEVE TEST. % (See Note F)	0.10-	0.10-	0.10-	0.10-	0.10-	0.10-	0.10-	0.10-	0.10-	0.10-	0.10-	0.10-	0.10-
CEMENT MIXING TEST. %	---	---	---	---	---	---	---	---	---	---	---	2-	2-
DISTILLATION TO 260°C [500°F]													
OIL DISTILLATE, % BY VOLUME	---	---	6.0-	3.0-	3.0-	3.0-	3.0-	3.0-	1.0-7.0	2.0-7.0	3.0-	---	---
RESIDUE, % BY WEIGHT	55+	63+	55+	65+	65+	55+	65+	65+	65+	65+	65+	57+	57+
TESTS ON DISTILLATION RESIDUE													
PENETRATION, 25°C 100G 5 s 0.1mm			100-200		60-90	100-200	60-90	200+		---	---	100-200	60-90
FLOAT TEST 60°C [140°F] , s			---		---		1200+			25-150	150-500	---	---
DUCTILITY, 25°C [77°F], 5 cm/min cm			60+		60+		60+			---	---	60+	60+

NOTES:

- A. Regardless of its viscosity, the emulsion shall be pumpable at 16 °C [60°F].
- B. The coating ability and water resistance shall be determined as described in AASHTO 759, except the aggregate shall be local aggregate. The use of calcium carbonate shall be omitted except limestone aggregate. The rating of "good" shall be required of dry aggregate, "fair" with wet aggregate, and "fair" for all aggregate after spraying and surface aid-drying at room temperature.
- C. 1. Wet Coating: Weigh 100 ± 0.5 g of aggregate, 20 to 30 mesh standard Ottawa sand, into a 800 ml glass becker and add soft tap water, approximately twice the volume of that of sand. Weigh into the becker containing the sand and water 8 ± 0.2 g of the emulsion at room temperature and mix for 2 minutes with a stiff spatula. Cover the mixture with approximately twice its own volume of tap water and pour the water off without further mixing. Repeat this process. After the second rinse, at least 75 percent of the sand shall remain coated.
2. Stripping: After evaluating the wet coating, place the mixture into a clean 800 ml glass becker, cover the mixture with tap water, let stand for 12 -16 hours and examine. At least 75 percent of the sand shall remain coated.
- D. The coating ability and water resistance test is waived when the material is used for tack coat or crack seal.
- E. The coating ability and water resistance test may be waived when the material is to be used in a hot mix or drum mixer. The coating and stripping test may be waived for sand seal use.
- F. The sieve test shall be 0.10% or less when tested in laboratory at the storage terminal of the manufacturer. When field or terminal samples are tested in laboratory other than manufacturer the sieve test shall be 0.30% or less.

G. The storage stability test is waived for HFMS-1.

The emulsion shall adhere firmly to the surface of the mineral aggregate even though the aggregate may be of hydrophilic character.

Cationic emulsified asphalt shall conform to AASHTO M208, except that Table 1 is modified to read as follows:

TYPE	Rapid	Setting	Medium	Setting	Slow	Setting
GRADE	CRS-1	CRS-2	CMS-2	CMS-2h	CSS-1	CSS-1h
TESTS:						
VISCOSITY, Soyball Fural at 25°C [77°F], seconds	-----	-----	-----	-----	20-100	20-100
at 50°C [122°F]	20-100	100-400	50-450	50-450	-----	-----
STORAGE STABILITY TEST, 24h %	1-	1-	1-	1-	1-	1-
DEMULSIBILITY, 35ml 0.8% SODIUM DIOCTYL SULFO SUCCINATE, %	40+	40+	-----	-----	-----	-----
COATING ABILITY & WATER RESISTANCE	-----	-----	B	B	-----	-----
PARTICLE CHARGE	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE
SIEVE TEST, %	0.10-	0.10-	0.10-	0.10-	0.10-	0.10-
CEMENT MIXING, %	-----	-----	-----	-----	2.0-	2.0-
DISTILLATION TO 360°C [500°F],						
OIL DISTILLATE, BY VOLUME OF EMULSION %	3-	3-	12-	12-	-----	-----
RESIDUE %	60+	65+	65+	65+	57+	57+
TESTS ON RESIDUE FROM DISTILLATION:						
PENETRATION, 25°C [77°F] 100 g 5 seconds 0.1 mm		100-250		60-90	00-250	60-90
DUCTILITY, 25 °C [77°F] 5 CM/MIN CM		60+		60+	60+	60+

*This table is modified from AASHTO M208-81, Table 1.

NOTES:

B> The coating ability and water resistance shall be determined as described in Section 48 through 53 of AASHTO T 59-86 except the aggregate shall be local aggregate. The use of calcium carbonate shall be omitted except for limestone aggregate. The rating of "good" shall be required of dry aggregate "fair" with wet aggregate, and "fair" for all aggregates after spraying surface air-drying at room temperature.

C> The coating ability and water resistance test is waived when the material is used for tack coat or crack seal.

D. The coating ability and water resistance test is waived when the material is to be used in a hot mix or drum mixer. The coating and stripping tests may be waived for sand seal use.

702.05 Application Temperatures. Bituminous materials for the several applications indicated in the specifications shall be used within the temperature ranges of the following table.

METRIC UNITS

<u>Material Type and Grade</u>	<u>Temperatures (°C)</u>	
Mixing	Spraying	
Asphalt Cement-all grades	121-163	-
Cut-Back		
Asphalt -MC-30	-	29-66
MC-70 -	43-82	
MC-250 57-79	60-104	
MC-800	74-99	77-127

MC-3000	82-116	93-149
Emulsified		
Asphalt -RS-1, HFMS-1, MS-4, MS-5	-	21-60
RS-2, CRS-1, CRS-2	-	52-85
MS-1, MS-2, MS-2h	10-71	21-71
HFMS-2, HFMS-2h, HFMS-2S	27-77	-
CMS-2, CMS-2h	10-71	21-71
SS-1, SS-1h, CSS-1, CSS-1h	10-71	21-71

ENGLISH UNITS

<u>Material Type and Grade</u>	<u>Temperatures (°F)</u>	
	Mixing	Spraying
Asphalt Cement-all grades	250-325	-
Cut-Back		
Asphalt -MC-30	-	85-150
MC-70	-	110-180
MC-250	135-175	140-220
MC-800	165-210	170-260
MC-3000	180-240	200-300
Emulsified		
Asphalt -RS-1, HFMS-1, MS-4, MS-5	-	70-140
RS-2, CRS-1, CRS-2	-	125-185
MS-1, MS-2, MS-2h	50-160	70-160
HFMS-2, HFMS-2h, HFMS-2S	80-170	-
CMS-2, CMS-2h	50-160	70-160
SS-1, SS-1h, CSS-1, CSS-1h	50-160	70-160

702.06 Temperature - Volume Correction Tables. All bituminous material shall be corrected for volume by use of the following multipliers to reduce the volume at the observed temperature to the volume at 16 °C [60 °F].

METRIC UNITS

EMULSIFIED		ASPHALTS			ASPHALTS			ASPHALTS	
ASPHALTS		(from ASTM	D 1250)		(from ASTM	D 1250)		(from ASTM	D 1250)
All Types and Grades	T °C	Group 0 Sp.Grave.	Group 1 Sp.Grave.	T °C	Group 0 Sp.Grave.	Group 1 Sp.Grave.	T °C	Group 0 Sp.Grave.	Group 1 Sp.Grave.
		0.966+	0.850		0.966+	0.850		0.966+	0.850
			0.966			0.966			0.966
1	10	1.0035	1.0040	66	.9689	.9647	121	.9352	.9268
1	13	1.0017	1.0020	68	.9672	.9628	124	.9336	.9249
1.0000	16	1.0000	1.0000	71	.9655	.9609	127	.9319	.9231
.9988	18	.9983	.9980	74	.9638	.9589	129	.9302	.9212
.9975	21	.9965	.9960	77	.9621	.9570	132	.9286	.9194
.9962	24	.9948	.9940	79	.9604	.9551	135	.9269	.9175
.9950	27	.9930	.9921	82	.9587	.9532	138	.9253	.9157
.9938	29	.9913	.9901	85	.9570	.9513	141	.9236	.9138
.9925	32	.9896	.9881	88	.9553	.9494	143	.9220	.9120
.9912	35	.9878	.9861	91	.9536	.9475	146	.9204	.9102
.9900	38	.9861	.9842	93	.9520	.9456	149	.9187	.9083
.9988	41	.9844	.9822	96	.9503	.9437	152	.9171	.9065
.9875	43	.9826	.9803	99	.9486	.9418	154	.9154	.9047
.9862	46	.9809	.9783	102	.9469	.9399	157	.9138	.9029
.9850	49	.9792	.9763	104	.9452	.9380	160	.9122	.9010
.9338	52	.9775	.9744	107	.9436	.9361	163	.9105	.8992
.9825	54	.9758	.9725	110	.9419	.9343	166	.9089	.8974
.9812	57	.9740	.9705	113	.9402	.9324	168	.9073	.8956
.9800	60	.9723	.9686	116	.9385	.9305	171	.9057	.8938
.9788	63	.9706	.9666	118	.9369	.9286	174	.9040	.8920
.9775	66	.9689	.9647	121	.9352	.9268	177	.9024	.8902

ENGLISH UNITS

EMULSIFIED		ASPHALTS			ASPHALTS			ASPHALTS	
ASPHALTS		(from ASTM	D 1250)		(from ASTM	D 1250)		(from ASTM	D 1250)
All Types and Grades	T °C	Group 0 Sp.Grave.	Group 1 Sp.Grave.	T °C	Group 0 Sp.Grave.	Group 1 Sp.Grave.	T °C	Group 0 Sp.Grave.	Group 1 Sp.Grave.
		0.966+	0.850		0.966+	0.850		0.966+	0.850
			0.966			0.966			0.966
1	50	1.0035	1.0040	150	.9689	.9647	250	.9352	.9268
1	55	1.0017	1.0020	155	.9672	.9628	255	.9336	.9249
1.0000	60	1.0000	1.0000	160	.9655	.9609	260	.9319	.9231
.9988	65	.9983	.9980	165	.9638	.9589	265	.9302	.9212
.9975	70	.9965	.9960	170	.9621	.9570	270	.9286	.9194
.9962	75	.9948	.9940	175	.9604	.9551	275	.9269	.9175
.9950	80	.9930	.9921	180	.9587	.9532	280	.9253	.9157
.9938	85	.9913	.9901	185	.9570	.9513	285	.9236	.9138
.9925	90	.9896	.9881	190	.9553	.9494	290	.9220	.9120
.9912	95	.9878	.9861	195	.9536	.9475	295	.9204	.9102
.9900	100	.9861	.9842	200	.9520	.9456	300	.9187	.9083
.9988	105	.9844	.9822	205	.9503	.9437	305	.9171	.9065

.9875	11 0	.9826	.9803	210	.9486	.9418	310	.9154	.9047
.9862	11 5	.9809	.9783	215	.9469	.9399	315	.9138	.9029
.9850	12 0	.9792	.9763	220	.9452	.9380	320	.9122	.9010
.9338	12 5	.9775	.9744	225	.9436	.9361	325	.9105	.8992
.9825	13 0	.9758	.9725	230	.9419	.9343	330	.9089	.8974
.9812	13 5	.9740	.9705	235	.9402	.9324	335	.9073	.8956
.9800	14 0	.9723	.9686	240	.9385	.9305	340	.9057	.8938
.9788	14 5	.9706	.9666	245	.9369	.9286	345	.9040	.8920
.9775	15 0	.9689	.9647	250	.9352	.9268	350	.9024	.8902

702.07 to 702.08 Vacant

702.09 Asphalt Filler for Structural Plate Arches. Asphalt for filling spaces between the structural plates and the substructure metal connectors of the arch shall conform to the requirements for bituminous material of AASHTO M190 or of AASHTO M226, Table 2, for viscosity grade AC-20 asphalt cement.

702.10 Vacant.

702.11 Vacant

702.12 Emulsified Bituminous Sealing Compound. Emulsified bituminous sealing compound shall be an approved commercially prepared product manufactured for specific protective coating, colored as required. It shall contain fillers, pigments and sand or fibrous materials suspended in a suitable emulsified asphalt or tar. It shall be of such consistency that it can be applied at atmospheric temperatures and capable of being easily diluted with the addition of water and mixed by hand stirring at the site of application.

SECTION 703 -- AGGREGATES

703.01 Fine Aggregate for Concrete. Fine aggregate for concrete shall consist of natural sand or, when approved by the Engineer, other inert materials with similar characteristics or combinations thereof, having strong, durable particles. Fine aggregate from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of construction or mix without permission of the Engineer.

All fine aggregate shall be free from injurious amounts of organic impurities. Should the fine aggregate, when subjected to the colorimetric test for organic impurities, AASHTO T21 (ASTM C40), produce a color darker than the reference standard color solution (laboratory designation Plate III), the fine aggregate shall be rejected.

The fine aggregate shall be well graded from coarse to fine material and shall meet the following grading requirements when tested according to AASHTO T11 and AASHTO T27.

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves
Metric	English	
9.5 mm	3/8 inch	100
4.75 mm	No. 4	95-100
2.36 mm	No. 8	80-100
1.18 mm	No. 16	50-85
600 m	No. 30	25-60
300 m	No. 50	10-30
150 m	No. 100	2-10
75 m	No. 200	0-5.0 maximum

Fine aggregate failing to meet the minimum requirements for material passing the 300 m and/or 150 m [No. 50 and/or No. 100] sieves may be retested and approved for use provided an approved inorganic fine material is added to correct the deficiency in grading.

The gradation requirements given above are the extreme limits to be used in determining the suitability of materials from all possible sources of supply.

The fineness modulus shall be not less than 2.3 nor more than 3.1, nor vary by more than 0.20 from the value assumed in selecting proportions of the concrete. If this value is exceeded, the fine aggregate will be rejected unless suitable adjustments are made in proportions of coarse and fine aggregate. The fineness modulus of fine aggregate shall be determined by adding the cumulative percentages of material by weight retained on the following sieves: 4.75 mm, 2.36 mm, 1.18 mm, 600 m, 300 m and 150 m [US Standard sieves Nos. 4, 8, 16, 30, 50, 100] and dividing by 100.

Mortar cubes containing the fine aggregates and made according to AASHTO T71 (ASTM C87) using cement conforming to AASHTO M85, Type II, shall develop compressive strength, at the age of 7 days, of not less than 90 percent of the strength developed by a mortar prepared in the same manner with the same cement and graded Ottawa sand having a fineness modulus of 2.40 plus or minus 0.10. After the initial test for each year and the fine aggregate has been accepted, the above compressive test will not be required unless the Engineer deems it necessary.

Fine aggregate, from an individual source or stockpile used for blending when tested for absorption as specified in AASHTO T84 (ASTM C128), shall show a percent of absorption of not more than 2.30.

703.02 Coarse Aggregate for Concrete. Coarse aggregate for concrete shall consist of crushed stone or gravel having hard, strong, durable pieces, free from adherent coatings and contain less than 15 percent, by weight, of thin or elongated pieces. A thin or elongated piece is defined as any piece whose length is greater than 5 times its maximum thickness.

The coarse aggregate shall not contain more than 3.0 percent, by weight, of deleterious material. No individual aggregate source or stockpile used for blending shall contain more than 4.0 percent, by weight, of deleterious material.

Deleterious material is defined as those particles of aggregate which may be crumbled in the hand and those which have an absorption greater than 3.0 percent by weight determined in accordance with AASHTO T85 modified for weight of sample. The types which are determined to be deleterious are generally highly absorptive shales, phylites, sandstones and rotten rock of various kinds.

Coarse aggregate shall conform to the requirements of the following table for the size or sizes designated and shall be well graded between the limits specified.

Percentage by Weight Passing a Square Mesh Sieve
METRIC UNITS

CLASSES	A B	AA AASF	S	LATEX
Sieve Designation				
50.0 mm			100	
37.5 mm	100		95-100	
25.0 mm	95-100	100	-	
19.0 mm	-	90-100	35-70	100
12.5 mm	25-60	-	-	90-100
9.5 mm	-	20-55	10-30	40-70
4.75 mm	0-10	0-10	0-5	0-15
2.36 mm	0-5	0-5	-	0-5
1.18 mm	-	-	-	-
300 m	-	-	-	-
75 m	1.5 Max.	1.5	1.5	1.5
ASTM C33	57	67	467	7
AGG. SIZE IN MILLIMETERS	25 mm	19 mm	37.5 mm	12.5 mm

Percentage by Weight Passing a Square Mesh Sieve
ENGLISH UNITS

CLASSES	A B	AA AASF	S	LATEX
Sieve Designation				
2 inch			100	
1½	100		95-100	
1 inch	95-100	100	-	
¾ inch	-	90-100	35-70	100
½ inch	25-60	-	-	90-100
3/8 inch	-	20-55	10-30	40-70
No. 4	0-10	0-10	0-5	0-15
No. 8	0-5	0-5	-	0-5
No. 16	-	-	-	-
No. 50	-	-	-	-
No. 200	1.5 Max	1.5	1.5	1.5
ASTM C33	57	67	467	7
AGG. SIZE IN INCHES	1 inch	¾ inch	1½ inch	½ inch

The material passing the 75 m [No. 200] sieve shall be determined in accordance with AASHTO T11 and AASHTO T27.

Coarse aggregate for a non-integral structural concrete wearing surface shall be hard and durable crushed ledge rock.

703.03 Vacant

703.04 Aggregate for Road Mix Bituminous Base. Aggregate for road mix bituminous base construction shall be crushed rock, crushed or natural gravel. The total aggregate shall be well graded and shall conform to the gradation specified in Subsection 703.11.

703.05 Aggregate for Sand Leveling. Aggregate for sand leveling shall be sand of hard durable particles free from vegetable matter, lumps or balls of clay and other deleterious substances. The gradation shall meet the grading requirements of the following table.

Sieve Designation		Percent by Weight Passing Square Mesh Sieve
Metric	English	
9.5 mm	3/8 inch	85-10
75 m	No. 200	0-5.0

703.06 Aggregate for Base and Subbase.

The material shall have a minimum degradation value of 15 as determined by the Washington State Degradation Test of 1967, except that the test will be run on the portion of a sample that passes the 12.5 mm [1/2 inch] sieve.

- (a) Aggregate for base shall be screened or crushed gravel of hard durable particles free from vegetable matter, lumps or balls of clay and other deleterious substances. The gradation of the part that passes a 75 mm [3 inch] sieve shall meet the grading requirements of the following table:

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves		
Metric	English	Aggregates		
		Type A	Type B	Type C
12.5 mm	½ inch	45-70	35-75	
6.3 mm	¼ inch	30-55	25-60	25-70
425 m	No. 40	0-20	0-25	0-30
75 m	No. 200	0-5.0	0-5.0	0-5.0

Type A aggregate for base shall only contain particles of rock which will pass the 50 mm [2 inch] square mesh sieve.

Type B aggregate for base shall only contain particles of rock which will pass the 100 mm [4 inch] square mesh sieve.

Type C aggregate for base shall only contain particles of rock which will pass the 150 mm [6 inch] square mesh sieve.

- (b) Aggregate for subbase shall be sand or gravel of hard durable particles free from vegetable matter, lumps or balls of clay and other deleterious substances. The gradation of the part that passes a 75 mm [3 inch] sieve shall meet the grading requirements of the following table:

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves			
Metric	English	Aggregates			
		Type D	Type E	Type F	Type G
6.3 mm	¼ inch	25-70	25-100	60-100	-
425 m	No. 40	0-30	0-50	0-50	0-70
75 m	No. 200	0-7.0	0-7.0	0-7.0	0-10.0

Aggregate for subbase shall not contain particles of rock which will not pass the 150 mm [6 inch] square mesh sieve.

703.07 Aggregates for Flexible Pavements. Coarse aggregate and fine aggregate for flexible pavements shall be of such gradation that when combined in proper portions,

including filler if required, the resultant blend will meet the composition of mixture for the type of pavement specified.

- (a) Coarse aggregate, that material retained on the 2.36 mm [No. 8] sieve, shall be crushed stone or crushed gravel and unless otherwise stipulated shall consist of clean, tough, durable fragments free from an excess of soft or disintegrated pieces and free from stone coated with dirt or other objectionable matter. The portion retained on the 9.5 mm [3/8 inch] sieve shall not contain more than 15 percent of particles, by weight, so flat or elongated or both that the ratio between maximum and minimum dimensions of a circumscribed rectangular prism exceeds 5:1.

When crushed gravel is used, not less than 60 percent of the particles retained on the 4.75 mm [No. 4] sieve, by weight, shall have at least 2 fractured faces. The coarse aggregate shall be of such gradation that, when combined with other required aggregate fractions in proper proportions, the resultant mixture will meet the gradations required under the composition of mixture for the type of pavement specified.

- (b) Fine aggregate, that material passing the 2.36 mm [No. 8] sieve, shall consist of natural sand or sand prepared from stone or gravel or combination thereof. It shall consist of hard, tough grains, free from injurious amounts of clay, loam or other deleterious substances. In addition, the absorption of the fine aggregate, as determined by AASHTO T84, shall not exceed 3.0 percent by weight for use in mixes exposed to traffic and weather.

The fine aggregate shall be of such gradation that when combined with other required aggregate fractions in the proper proportions, the resultant mixtures will meet the gradation requirements.

- (c) Composition of Mixture. The following requirements shall apply to the composite blend resulting when the stockpiled aggregates are combined to produce a mixture conforming to the specified tolerances to the gradation stated in the job mix formula.

The entire wearing course shall come from the same source of material, except when permission is obtained from the Engineer to change sources.

The amount of natural or crushed gravel aggregates retained on the 2.36 mm [No. 8] sieve in a composite blend requiring crushed ledge aggregate shall not exceed 15 percent of the total aggregate.

Samples of the composite blend obtained immediately prior to addition of bituminous material shall be tested in accordance with AASHTO T176. The sand equivalent value found shall be in excess of 50.

The composite blend, minus any reclaimed asphalt pavement used, shall have a minimum degradation value of 30. The degradation value shall be determined by the Washington State Degradation test of 1967.

703.08 Vacant

703.09 Aggregate for Plant Mix Hot Bituminous Pavement. The coarse and fine aggregate shall meet the requirements of Subsection 703.07. The several aggregate fractions for mixtures shall be sized, graded and combined in such proportions that the resulting composite blends will meet the grading requirements of the following tables or as otherwise specified.

Percentage by Weight Passing Square Mesh Sieves
Metric Units

Sieve Designation	A	B	Grading C	D	E
50 mm	100	-	-	-	-
37.5 mm	90-100	-	-	-	-
25.0 mm	-	100	-	-	-
19.0 mm	50-80	80-100	100	-	-
12.5 mm	-	50-85	80-100	100	100
9.5 mm	35-65	-	65-100	93-100	90-100
4.75 mm	25-50	28-60	40-70	60-80	70-100
2.36 mm	20-40	20-50	26-52	46-65	50-90
1.18 mm	13-33	14-39	17-40	25-55	36-78
600 m	-	-	10-30	16-40	24-66
300 m	6-24	6-24	7-22	10-30	15-50
150 m	4-16	4-16	4-14	6-22	8-30
75 m	1.0-8.0	1.0-8.0	2.0-7.0	3.0-8.0	3.0-8.0

Percentage by Weight Passing Square Mesh Sieves
English Units

Sieve Designation	A	B	Grading C	D	E
2 inch	100	-	-	-	-
1½ inch	90-100	-	-	-	-
1 inch	-	100	-	-	-
¾ inch	50-80	80-100	100	-	-
½ inch	-	50-85	80-100	100	100
3/8 inch	35-65	-	65-100	93-100	90-100
No. 4	25-50	28-60	40-70	60-80	70-100
No. 8	20-40	20-50	26-52	46-65	50-90
No. 16	13-33	14-39	17-40	25-55	36-78
No. 30	-	-	10-30	16-40	24-66
No. 50	6-24	6-24	7-22	10-30	15-50
No. 100	4-16	4-16	4-14	6-22	8-30
No. 200	1.0-8.0	1.0-8.0	2.0-7.0	3.0-8.0	3.0-8.0

703.10 Aggregate for Untreated Surface Course and Leveling Course. Aggregate for untreated surface course and leveling course shall be screened or crushed gravel consisting of hard durable particles which are free from vegetable matter, lumps or balls of clay and other deleterious substances. The gradation of the material shall meet the grading requirements of the following table:

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves
Metric	English	
25.0 mm	1 inch	95-100
19.0 mm	¾ inch	90-100
4.75 mm	No. 4	40-65
2.00 mm	No. 10	10-45
75 m	No. 200	0-7.0

703.11 Aggregate for Road Mix Bituminous Pavement. Aggregate for road mix bituminous pavement shall be crushed rock or crushed or natural gravel. At least 25 percent of the gravel retained on the 4.75 mm [Number 4] sieve shall have one crushed face if crushed material is specified. The total aggregate shall be well graded and shall conform to the following gradation requirements as specified.

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves	
		Gradation A	Gradation B
Metric	English	Crushed Stone or Crushed Gravel	Uncrushed Gravel
37.5 mm	1½ inch	-	100
25.0 mm	1 inch	100	95-100
19.0 mm	¾ inch	90-100	70-90
4.75 mm	No. 4	45-65	30-50
2.36 mm	No. 8	32-52	-
300 m	No. 50	10-22	-
75 m	No. 200	2.0-8.0	0-5.0

703.12 Vacant

703.13 Aggregate for Cover Coat Material. Stone chip aggregate shall be crushed stone or crushed gravel that will meet the following elongation requirement: Not over 8 percent of the pieces shall have a length greater than 5 times their maximum thickness. The aggregate shall contain not more than 8 percent by weight of deleterious material. Deleterious material is defined in Subsection 703.02. Sand cover shall be granular material consisting of hard durable particles which are free from vegetable matter, lumps or balls of clay and other deleterious substances. Only one type of aggregate shall be used on the project unless alternate types are approved. The gradation of the materials shall conform to the grading requirements of the following table:

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves	
		Stone Chips	Sand Cover
Metric	English		
12.5 mm	½ inch	100	-
9.5 mm	3/8 inch	85-100	85-100
4.75 mm	No. 4	10-30	50-80
2.36 mm	No. 8	0-10	-
1.18 mm	No. 16	0-5	-
75 m	No. 200	-	0-5.0

When tested in accordance with AASHTO T182, (ASTM D1664) the stone chip aggregate shall have a retained bituminous film above 95 percent. The stripping tests may be omitted if the total quantity of stone chip aggregate is less than 50 m³ [50 cubic yards] or if it comes from a source which has given satisfactory performance.

703.14 Blotter. Aggregate for blotter material shall consist of sharp durable particles of sand conforming to the following table:

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves
Metric	English	
19.0 mm	3/4 inch	100
4.75 mm	No. 4	40-100
425 m	No. 40	10-50
75 m	No. 200	0-5.0

The aggregate shall be free from vegetable and other deleterious material.

703.15 Filler. These materials shall conform to the following specification requirements for the designated materials.

Mineral filler shall conform to the requirements of AASHTO M17.

Ground limestone shall meet the following gradation requirements:

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves
Metric	English	
2.36 mm	No. 8	100
300 m	No. 50	80-100
75 m	No. 200	30.0-70.0

703.16 Vacant

703.17 Aggregate for Stabilized Base. Aggregates for bituminous stabilized base course shall consist of granular material containing hard, durable particles conforming to the gradation requirements of the following table:

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves
Metric	English	
37.5 mm	1½ inch	100
9.5 mm	3/8 inch	60-100
4.75 mm	No. 4	50-85
2.36 mm	No. 8	38-74
300 m	No. 50	8-34
75 m	No. 200	0-10.0

The gradation shall be uniform within the limits specified and shall not vary from the low limit on one sieve size to the high limit on the adjacent sieve size.

703.18 Common Borrow. Common borrow shall consist of earth, suitable for embankment construction. It shall be free from frozen material, perishable rubbish, peat and other unsuitable material.

The moisture content shall be sufficient to provide the required compaction and stable embankment. In no case shall the moisture content exceed 4 percent above optimum which shall be determined in accordance with AASHTO T180, Method C or D.

703.19 Granular Borrow. Granular borrow shall consist of sand or gravel of hard durable particles free from vegetable matter, lumps or balls of clay and other deleterious substances. The gradation of that portion passing a 75 mm [3 inch] sieve shall meet the gradation requirements of the following table:

Sieve Designation Metric English	Percentage by Weight Passing Square Mesh Sieves	
	Material for Underwater Backfill	Material for Embankment Construction
425 m No. 40	0-70	0-70
75 m No. 200	0-10.0	0-20.0

Granular borrow shall contain no particles or fragments with a maximum dimension in excess of the compacted thickness of the layer being placed.

703.20 Gravel Borrow. Gravel borrow shall consist of uniformly graded granular material having no rocks with a maximum dimension of over 150 mm [6 inches] and that portion passing a 75 mm [3 inch] square mesh sieve shall contain not more than 70 percent passing a 6.3 mm [$\frac{1}{4}$ inch] mesh sieve and not more than 10 percent passing a 75 m [No. 200] mesh sieve.

703.21 Rock Borrow. Rock borrow shall consist of hard durable rock broken to various sizes that will form a compact embankment with a minimum of voids. The maximum size for any rock shall be 900 mm [3 feet] in its greatest dimension.

703.22 Underdrain Backfill Material. Granular material for Underdrain Type B shall be free from organic matter and shall conform to the following table:

Sieve Designation Metric English		Percentage by Weight Passing Square Mesh Sieves
25.0 mm	1 inch	95-100
12.5 mm	$\frac{1}{2}$ inch	75-100
4.75 mm	No. 4	50-100
850 m	No. 20	15-80
300 m	No. 50	0-15
75 m	No. 200	0-5.0

Crushed or uncrushed material for Underdrain Type C shall conform to the following table:

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves
Metric	English	
25.0 mm	1 inch	100
19.0 mm	¾ inch	90-100
9.5 mm	3/8 inch	0-75
4.75 mm	No. 4	0-25
2.00 mm	No. 10	0-5.0

703.23 Vacant

703.24 Stone for French Drains. Stones for French drains shall consist of hard, durable rock and shall conform to the following table:

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves
Metric	English	
150 mm	6 inch	90-100
37.5 mm	1½ inch	0-40
4.75 mm	No. 4	0-5

Gradation test shall conform to AASHTO T27 except that the total sample shall be sieved and the minimum weight of the sample will be 55 kg [120 pounds].

703.25 Stone Fill. Stones for stone fill shall consist of sound durable rock which will not disintegrate by exposure to water or weather. Either field stone or rough, unhewn quarry stone may be used. Stones shall weigh from 5 kg [10 pounds] to a maximum of 225 kg [500 pounds] or larger if approved by the Engineer. Fifty percent by weight of the stones, shall be approximately 100 kg [200 pounds].

703.26 Plain and Hand Laid Riprap. Stones shall consist of sound durable rock which will not disintegrate by exposure to water or weather. Either field stone or rough, unhewn quarry stone may be used. Exposed stones shall be angular and as nearly rectangular in cross-section as practicable. Rounded boulders or cobbles will not be permitted. Stones shall weigh from 5 kg [10 pounds] to 100 kg [200 pounds] except that when available suitable stones weighing more than 90 kg [200 pounds] may be used. Approximately 50 percent of the stones by volume, shall exceed a mass of 25 kg [50 pounds] each.

703.27 Stone Blanket. Stones shall consist of sound durable rock which will not disintegrate by exposure to water or wind. Either field stone or rough, unhewn quarry stone may be used. Stones shall weigh from 150 kg [300 pounds] to 1500 kg [3,000 pounds]. Approximately 50 percent of the stones, by volume, shall exceed a mass of 450 kg [1,000 pounds] each.

703.28 Heavy Riprap. Stones shall consist of sound, durable rock, resistant to the action of air and water. Either field stone or rough, unhewn quarry stone may be used. The exposed stones

shall be angular. Round or thin, flat stones will not be permitted. Stones shall have a minimum weight of 225 kg [500 pounds] each and at least 50 percent of the stones, by volume, shall exceed 450 kg [1,000 pounds] each.

703.29 Stone Ditch Protection. Rock used for ditch protection shall consist of sound, durable rock which will not disintegrate by exposure to water or weather. Field stone, rough quarry stone, blasted ledge rock or tailings may be used. The rock shall be graded within the following limits or as otherwise approved.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
300 mm [12 inch]	90-100
100 mm [4 inch]	0-15

The size of any stone shall not exceed 450 mm [18 inches] when measured along its longest axis.

703.30 Vacant

703.31 Crushed Stone. Crushed stone shall be obtained from rock of uniform quality and shall consist of clean, angular fragments of quarried rock, free from soft disintegrated pieces or other objectionable matter.

The stone, which shall be similar to railroad ballast, shall meet the following gradation requirements in the stockpile at the source.

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves
Metric	English	
63 mm	2½ inch	100
50 mm	2 inch	95-10
25 mm	1 inch	0-30
19 mm	¾ inch	0-5

SECTION 704 -- MASONRY UNITS

704.01 Clay or Shale Brick. Except as modified below, brick shall conform to the requirements of one of the following specifications:

Type of Brick	Specification
Sewer and Manhole	AASHTO M91, Grade MS or SM
Building	AASHTO M114, Grade SW

Size Number 1 brick of a nominal length of 190 mm [7 inches] may be used.

704.02 Brick for Paving. Brick for paving shall conform to the requirements of ASTM (C62, Grade SW) for Building brick or shale, with the following modifications:

- (a) The absorption limits shall be from 5 to 12 percent for the average of five bricks.
- (b) The compressive strength shall not be less than 41.4 MPa [6,000 pounds per square inch].
- (c) The modulus of rupture shall not be less than 6.9 MPa [1,000 pounds per square inch].
- (d) The bricks shall be No. 1, water struck type for paving.

The bricks shall be 57x90x190 mm [$2\frac{1}{4}$ x3 $\frac{3}{4}$ x8 inches] with permissible variations not to exceed 1.5 mm [$\frac{1}{16}$ inch] in depth, 3 mm [inch] in width and 6 mm [$\frac{1}{4}$ inch] in length.

Prior to ordering new brick, samples shall be submitted in whole straps to show color range.

704.03 Concrete Masonry Blocks. Concrete masonry blocks may be rectangular or segmented and when specified shall have ends shaped to provide interlock at vertical joints.

Hollow blocks shall conform to the requirements of ASTM C90, Grade N-II, except paragraph 3.2(1). Aggregates shall meet the requirements of Section 703.01 and 703.02 for fine aggregates and coarse aggregates respectively except that grading requirements are hereby waived.

Solid blocks for catch basins and manholes shall conform to the requirements of ASTM C139.

SECTION 705 -- JOINT MATERIAL

705.01 Preformed Expansion Joint Filler. Preformed expansion joint filler shall be non-extruding and resilient bituminous type and shall conform to the requirements of AASHTO M213 (ASTM D1751).

705.02 Joint Mortar. Joint mortar shall consist of 1 part portland cement, 2 parts sand and sufficient water to obtain the required consistency. Mortar shall be used within 30 minutes after its preparation.

The cement shall conform to the requirements of portland cement AASHTO M85, Type II or IIA.

The sand shall meet the requirements of the following table:

METRIC UNITS

Sieve Designation	Percentage by Weight Passing Square Mesh Sieve	
	Joints Thicker Than 13 mm	Joints 13 mm or Thinner
9.5 mm	100	-
6.3 mm	-	100
4.75 mm	95-100	-
2.36 mm	70-95	85-100
1.18 mm	45-80	60-90
600 m	25-55	35-70
300 m	10-30	15-45
150 m	2-10	0-15
75 m	0-5.0	0-5.0

ENGLISH UNITS

Sieve Designation	Percentage by Weight Passing Square Mesh Sieve	
	Joints Thicker Than ½ inch	Joints ½ inch or Thinner
3/8 inch	100	-
¼ inch	-	100
No. 4	95-100	-
No. 8	70-95	85-100
No. 16	45-80	60-90
No. 30	25-55	35-70
No. 50	10-30	15-45
No. 100	2-10	0-15
No. 200	0-5.0	0-5.0

When necessary, material retained on the 4.75 mm [Number 4] sieve may be removed.

The sand shall be subjected to the colorimetric test for organic impurities, AASHTO T21, (ASTM C40) and when a color darker than the reference standard color solution (laboratory designation Plate III) is produced, the material shall be rejected.

705.03 Flexible Gaskets. Flexible gaskets, either rubber or plastic, shall conform to AASHTO M198, Type A or Type B, respectively.

SECTION 706 -- NON-METALLIC PIPE

706.01 Vacant

706.02 Reinforced Concrete Pipe. This pipe shall conform to the requirements of AASHTO M170M (ASTM C76M) [AASHTO M170, ASTM C76] except paragraph 6.2. Elliptical pipe shall conform to the requirements of AASHTO M207M [AASHTO M207] except paragraph 6.2. Unless otherwise specified, pipe wall design and use of elliptical reinforcement in circular pipe are optional. Pipe arch shall conform to the requirements of AASHTO M206M [AASHTO M206], except paragraph 6.2.

Aggregates shall meet the requirements of Subsections 703.01 and 703.02 for fine aggregates and coarse aggregates respectively, except that grading requirements are hereby waived.

Precast reinforced concrete special sections shall conform to the requirements of the cited specifications to the extent to which they apply.

706.03 Vacant

706.04 Vacant

706.05 Vacant

706.06 Corrugated Polyethylene Drainage Tubing for Underdrain. This pipe and fittings shall conform to the requirements of AASHTO M252, slot-perforated, for 150 mm [6 inch] diameter and to AASHTO M294 for diameters 300 to 600 mm [12 to 24 inches]. Pipe to be used for Underdrain Type C shall be perforated in accordance with the applicable perforation requirements of AASHTO M36/M36M Type III, Class I perforations. All polyethylene tubing and pipe shall be smooth lined (exterior corrugations with a smooth inner liner) and shall meet the pipe stiffness requirements shown on the Standard Details.

706.07 Vacant

706.08 PVC (Polyvinylchloride) Pipe. This pipe and fittings shall conform to the requirements of AASHTO M278. All pipe shall be supplied with gasket type joints meeting the requirements of ASTM D3212.

706.09 PVC (Polyvinylchloride) Perforated Pipe. This pipe and fittings shall conform to the requirements of AASHTO M278 or ASTM F949 for 150 mm [6 inch] underdrain and AASHTO M278 for underdrain larger than 150 mm [6 inch] diameter.

SECTION 707 -- METALLIC PIPE

707.01 Vacant

707.02 Corrugated Steel, Metallic Coated Pipe. This pipe and special fittings such as elbows, tees and wyes shall conform to the requirements of AASHTO M36/M36M Type I, II or III for the specified sectional dimensions, sheet thickness and coating.

707.03 Vacant

707.04 Fiber-bonded Corrugated Steel Pipe. This pipe and the coupling bands shall conform to the requirements of AASHTO M36/M36M for the specified sectional dimensions and sheet thickness except that steel sheet shall conform to the requirement of ASTM A885.

Immediately after the metallic bond has solidified the fibers shall be thoroughly saturated with a bituminous saturant conforming to the following requirements:

Penetration at 25 °C, 100 g., 5 sec.	35-45
Loss on heating at 163 °C [325 °F] 50g., 5 hrs.	Not more than 1.5%
Flash point (open cup)	Not less than 225 °C[440 °F]
Penetration at 25 °C, 100g., 5 sec. of residue after heating at 163 °C, [325 °F] as compared with penetration of asphalt before heating	Not less than 70%
Insoluble in carbon disulfide	Not more than 2%

Testing shall be in accordance with methods specified in AASHTO M20.

707.05 Corrugated Steel, Metallic Coated Pipe for Underdrain. This pipe and special fittings such as elbows, tees and wyes shall conform to the requirements of AASHTO M36/M36M, Type III, Class 1 perforations.

707.06 Corrugated Aluminum Alloy Pipe and Pipe Arches. This pipe and special fittings such as elbows, tees and wyes shall conform to the requirements of AASHTO M196/M196M, Type I or II. Special sections, such as elbows and metal end sections, shall be of the thickness called for on the plans and shall conform to the applicable requirements of AASHTO M196/M196M. Aluminum sheet shall conform to the requirements of AASHTO M197/M197M.

707.07 Polymer Precoated, Galvanized Corrugated Steel Pipe and Pipe Arches. This pipe and special fittings such as elbows, tees and wyes shall conform to the requirements of AASHTO M245/M245M, Grade 250/75 [Type I, with Type B coating] for the pipe as specified in AASHTO M246/M246M with the thinner coating on the outside.

707.08 Corrugated Aluminum Alloy Pipe for Underdrain. This pipe and special fittings such as elbows, tees and wyes shall conform to the requirements of AASHTO M196/M196M, Type III, Class 1 perforations.

707.09 Steel Structural Plate Pipe, Pipe Arches and Arches. Plates, bolts, nuts and other accessories shall conform to the requirements of AASHTO M167/M167M and the following additional requirements:

- (a) All shop welding shall meet the requirements of the latest edition of AWS D1.1, Structural Welding Code - Steel.
- (b) Annually the fabricator shall have quality control tests performed on uncoated random samples of the lightest and heaviest thickness plates produced by welding. The sampling and testing shall be done by a recognized independent testing agency and copies of the test reports, including all welding parameters, shall be submitted to the Engineer on an annual basis.
- (c) The Engineer reserves the right to conduct unannounced inspections of the fabricators facilities and to take random samples of welded plates representative of gages supplied to the Department.
- (d) No field welding will be allowed.

707.10 Aluminum Coated (Type 2) Corrugated Steel Pipe. This pipe shall conform to the requirements of AASHTO M36/M36M using steel sheet conforming to AASHTO M274.

707.11 Zinc - Coated (Galvanized) Corrugated Steel Pipe. This pipe shall conform to the requirements of AASHTO M36/M36M using steel sheet conforming to AASHTO M218.

707.14 Aluminum Alloy Structural Plate Pipe, Pipe Arches and Arches. Plates, bolts and nuts for this pipe shall conform to the requirements of AASHTO M219/M219M.

707.15 Vacant

SECTION 708 -- PAINTS AND PRESERVATIVES

708.01 Exterior Ready Mixed Paint. Exterior paint for wood structures shall conform to the requirements of AASHTO M70, Type 3. When white paint is called for the paint shall be Class A. When tinting is required Class B shall be supplied.

708.02 Vacant

708.03 Pavement Marking Paint. Paint for final and temporary pavement marking shall meet the requirements of AASHTO M248. Either Type N, regular dry traffic paint or Type F, fast dry traffic paint may be used.

Glass beads shall conform to the requirements of AASHTO M247, Type I.

708.04 Tree Wound Paint. Tree wound paint shall be an approved waterproof, adhesive and elastic paint, manufactured and customarily used for painting cuts on trees. It shall contain an antiseptic ingredient and be free from kerosene, creosote, coal tar or any other injurious material.

708.05 Timber Preservative. Timber preservatives shall conform to the requirements of AASHTO M133.

SECTION 709 -- REINFORCING STEEL AND WELDED STEEL WIRE FABRIC

709.01 Reinforcing Steel. Reinforcing steel both plain and epoxy coated, shall be deformed bars conforming to the requirements of AASHTO M31M [AASHTO M31]. Bars shall be Grade 400 [Grade 60] unless otherwise specified on the plans. Epoxy coated reinforcing steel shall also conform to the requirements of ASTM A775/A775M, and the requirements of A775/A775M, paragraph 4.2.1., 4.3. 4.4 and 14.1 shall be mandatory.

Fabricated steel bar or rod mats shall conform to the requirements of AASHTO M54/M54M (ASTM A184/A184M).

709.02 Welded Steel Wire Fabric. Welded steel wire fabric shall conform to the requirements of AASHTO M55 (ASTM A185).

SECTION 710 -- FENCE AND GUARDRAIL

710.01 Barbed Wire. Barbed wire shall conform to the requirements of ASTM A121, Class 3 if zinc coated or ASTM A585, Class I if aluminum coated. The wire shall be 12½ gage, 4 point round barbs wrapped around both wires, interlocked with one barb projecting through the strand and spaced 150 mm [6 inches] apart or less.

710.02 Woven Wire. Wire and stays shall conform to the requirements of ASTM A116, Class 3 if zinc coated or ASTM A584, if aluminum coated.

710.03 Chain Link Fabric. Chain Link fabric shall conform to the requirements of AASHTO M181, Type I, Class D or Type II.

710.04 Metal Beam Rail. The rails shall conform to the requirements of AASHTO M180, Class A, Type I or Type IV as designated.

When metal beam rail is to be installed on a curve having a radius of curvature of 45 m [150 feet] or less, the beam sections shall be fabricated on an arc to the required radius.

710.05 Cedar Rail Fence. Rails and posts for cedar rail fence shall be of cedar, reasonably straight, machine or hand peeled and branch stubs cut flush.

710.06 Fence Posts and Braces. Wood posts shall be of cedar, white oak or tamarack, of the diameter or section and length shown on the plans.

Round wood posts shall be of seasoned stock straight and sound and shall have been cut from live growing trees with the outer and inner bark removed and all knots trimmed flush with the surface of the post. Rotted, loose or hollow knots, plugged or open holes will not be permitted. Sound knots will be permitted if the diameter of any one knot or the combined diameter of 2 or more knots occurring in the same cross section is not greater than one-third of the circumference of the post at that cross section. Posts shall be of uniform taper from top to bottom not to exceed 40 mm [1½ inches] in taper in 2100 mm [7 feet].

The minimum diameter of heartwood in line posts at their small end shall be no less than 75 mm [3 inches]. The minimum diameter of line posts at the small end shall be no less than 75 mm [3 inches]. The maximum diameter of line posts at the small end shall be 150 mm [6 inches]. The minimum diameter of heartwood in end, corner, gate and barway posts shall be 110 mm [4½ inches] at the small end. The minimum diameter of end, corner, gate and barway posts at the small end shall be 110 [4½ inches]. The maximum diameter of end, corner, gate and barway posts shall be 200 mm [8 inches].

That portion of wood posts to be set below ground shall be immersed to a depth of 1200 mm [4 feet] in a tank or barrel containing an approved commercial timber preservative solution for a minimum of 60 minutes. All wood posts so treated, unless otherwise specified by the Engineer, shall have been peeled and air seasoned to permit thorough drying for at least 3 months prior to treatment. After being treated, the posts shall be piled to permit thorough drying before being set in the ground.

Braces shall be of spruce, eastern hemlock, Norway pine, pitch pine or tamarack timbers or spruce, cedar or tamarack round posts of sufficient length to make a diagonal brace between adjacent posts. If other than cedar, white oak or tamarack, braces shall be treated as described above for posts except that they shall be immersed full length.

Metal posts and braces for woven wire fence shall be of new billet steel conforming to the requirements of ASTM A615M [ASTM A615] or Commercial Standard 184-51, or shall be rail steel conforming to the requirements of ASTM A616/A616M, or ASTM A499. Posts shall be galvanized according to the requirements of AASHTO M111. Steel pipe used for woven wire fence corner posts, for rails and for bracing shall conform to the requirements of ASTM A53, galvanized.

Metal posts, rails and bracing for chain link fence shall be as specified in AASHTO M181. Expansion sleeves, turnbuckles and other fittings and hardware shall be galvanized in accordance with the applicable requirements of ASTM A153.

710.07 Guardrail Posts. Posts shall be of wood or steel.

- (a) Wood posts shall be of cedar, tamarack, white oak, Norway pine, southern yellow pine, pitch pine, Douglas fir, maple, beech, birch or red oak. They shall be of well seasoned, straight and sound timber cut from live growing trees, free from loose knots or other structurally weakening defects, including shake, holes and heart rot over 25 mm [1 inch] in diameter. The posts shall be free from season checks that exceed 6 mm [$\frac{1}{4}$ inch] in width. A tolerance of 25 mm [1 inch] in length and 6 mm [$\frac{1}{4}$ inch] in width or thickness is permitted in the dimensions of rectangular posts. They shall be well sawn and have square edges except that wane not more than 38 mm [$1\frac{1}{2}$ inches] wide and extending not more than $\frac{1}{2}$ the length of the piece will be allowed on that portion of the post to be placed below ground. Sound, tight, well spaced knots to 64 mm [$2\frac{1}{2}$ inches] diameter will be permitted.

Wood posts and offset brackets shall be preservative treated in accordance with the requirements of AASHTO M133 using pentachlorophenol or chromate copper arsenate preservative. Treatment shall be according to the Standards of AWPA C5.

Composite material blocks tested and meeting the requirements of the National Cooperative Research Program Report 230, Test 10 and 12 and approved by the FHWA may be used as offset brackets.

- (b) Galvanized steel posts shall conform to the requirements of AASHTO M183/M183M if a rolled section or ASTM A769/A769M Grade 36 if a welded section. Fabrication will be in accordance with Section 504. Galvanizing shall be in accordance with AASHTO M111.
- (c) Corrosion resistant steel posts shall conform to the requirements of ASTM A769/A769M, Grade 50W if a welded section. Fabrication will be in accordance with Section 504.

710.08 Guardrail Hardware. Guardrail hardware shall conform to the applicable standards contained in the latest ARTBA Bulletin No. 268B, "A Guide to Standardized Highway Barrier Rail Hardware", approved by the AASHTO-ARTBA-AGC Joint Cooperative Committee, Technical Bulletin Number 268-B.

All galvanized fittings, bolts, washers, twisted end section anchors and other accessories shall be in accordance with the requirements of AASHTO M111, M232 or AASHTO M298, Class 50, Type I, whichever applies. All galvanizing shall be done after fabrication.

Hardware for corrosion resistant guard rail shall be in accordance with ASTM A325M [ASTM A325], Type 3, except the 400 mm [16 inch] bolts and nuts for attaching the metal beam rail to the posts which may be galvanized as specified above.

SECTION 711 -- MISCELLANEOUS BRIDGE MATERIAL

711.01 Steel Pipe Piles. Steel pipe piles shall conform to the requirements of ASTM A252, Grade 2 with either straight or spiral - butt welded seams for welded pipe piles. Spiral lap construction will not be allowed. Additionally the pipe piles shall conform to the weld soundness requirements of ASTM A53, Section 9 and the tensile requirement of ASTM A53 paragraph 7.3.

Cast steel points shall conform to the requirements of ASTM A27/A27M Grade 450-240, [Grade 65-35] or ASTM A148/A148M Grade 620-415, [Grade 90-60].

Pile splices shall conform to, or exceed, the strength requirements of ASTM A36/A36M, or ASTM A47M Grade 22010 [ASTM A47, Grade 32510] and as applicable.

711.02 Gabions. Each shipment of gabions to a job site shall be accompanied by a certificate which states that the material conforms to the requirements of this specification. The certificate shall be on manufacturer's letterhead and shall be signed by an officer of the company having legal authority to bind the company.

Mesh openings shall be hexagonal in shape, measuring approximately 75 by 100 mm [3 by 4 inches] and shall be uniform in size. Double twist mesh joints shall be flexible with each pair of wires twisted three half turns, commonly called triple twisted, to prevent unraveling. Steel wire and galvanizing shall meet the requirements of ASTM A641M [ASTM A641] and ASTM A90, shall have a Class 3 coating and shall be soft temper. The wire mesh shall have a sufficient elasticity to permit elongation of the mesh equivalent to a minimum of 10 percent of its length.

(a) Galvanized Gabions without Polyvinylchloride Coating. The diameter of the steel wire mesh shall be 3 mm [0.1181 inches] after galvanizing. The diameter of the selvedge wire, running through all the edges (perimeter wire), shall be 3.899 mm [0.1535 inches] after galvanizing. The diameter of the wire for assembling and lacing the gabion units shall be 2.2 mm [0.0866 inches] after galvanizing. The above wire sizes shall have a tolerance of ± 2.50 percent.

(b) Polyvinylchloride (PVC) Coated Gabions. When specified on the plans, all galvanized steel wire shall be coated with a minimum of 0.38 mm [0.015 inches] of gray or green PVC, which shall be suitable to resist the destructive effects of immersion in acidic, salt, or polluted water, exposure to ultra violet light and abrasion and retain these characteristics after a period of not less than 3,000 hours when tested in accordance with ASTM G23. The diameter of the steel wire mesh shall be 2.70 mm [0.1063 inches] after galvanization and 3.46 mm [0.1363 inches] overall, core wire plus PVC coating.

The diameter of the selvedge wire running through all the edges (perimeter wire) shall be 3.399 mm [0.1338 inches] after galvanizing and 4.161 mm [0.1638 inches] overall, core wire plus PVC coating. The diameter of the wire for assembling and lacing the gabion units shall be 2.2 mm [0.0866 inches] after galvanizing and 2.962 mm [0.1166 inches] overall, core wire plus PVC coating. All wire sizes shall have a tolerance of ± 2.50 percent, the thickness of the PVC excluded.

The mesh shall be capable of withstanding the test described below:

An uncut section of mesh 2 m [6 feet] long and of a minimum width of 1 m [3 feet], including all selvage bindings, shall have the ends securely clamped for 1 m [3 feet] along the width of the sample. When the width of the section under test exceeds 1 m [3 feet], the clamps shall be placed in the middle portion of the width and the excess width shall be allowed to fall free on each side of the clamped section. The sample shall then be subjected to sufficient tension to cause 10 percent elongation of the sample section between clamps. After elongation and while clamped as described above (and otherwise unsupported), the section shall be subjected to a load applied to an area of 0.09 m² [1 square foot] located approximately in the center of the sample section between the clamps and in a direction perpendicular to the direction of the tensile force. The sample shall withstand without rupture of any wire or opening of any mesh fastening, an actual load, so applied, equaling or exceeding 2720 kg [6,000 pounds]. The ram head used in the test shall be circular with its edges beveled or rounded to prevent cutting the wires.

711.03 Stones for Gabions. Stones to fill gabions shall be of clean, hard and durable rock with a minimum dimension of 100 mm [4 inches] in all directions and a maximum dimension of 300 mm [12 inches].

Stones to fill hand filled gabions shall be of clean, hard, durable, crushed ledge or quarried rock with a minimum dimension of 100 mm [4 inches] in all directions and a maximum of 300 mm [12 inches].

711.04 Bridge Drains. The tubular sections(s) of bridge drains shall conform to the requirements of either ASTM A53, Grade B, Type E or S, black, ASTM A500, Grade B, or ASTM A501. Bars, plates, structural shapes, and grating shall conform to the requirements of ASTM A36/A36M, except the beam attachment of the drain standoff bracket, when attached to structural steel, shall meet the material specification of the web of the beam to which it is attached and shall have the same protective coating, if any, as the structural steel.

All welding shall be in accordance with the requirements of Subsection 504.20, Welding.

The drains and standoff brackets shall be cleaned to the requirements of SSPC SP6 and shall be hot-dipped galvanized to conform to the requirements of ASTM A123, except as above specified for the beam attachment of the standoff bracket.

711.05 Protective Coating for Concrete Surfaces. The coating shall be a blend of 50 percent by volume boiled linseed oil and 50 percent petroleum spirits. The linseed oil shall comply with the requirements of ASTM D260. Petroleum spirits shall be kerosene, diesel fuel or shall be mineral spirits complying to the requirements of ASTM D235. CAUTION: This blend is flammable.

711.06 Stud Shear Connectors, Anchors and Fasteners. Steel studs shall conform to AASHTO M169, cold drawn bars, grade 1015 through 1020, either semi-killed 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 ASTM A109M [ASTM A109].

Tensile properties shall be determined by tests of bar stock after drawing or by full diameter finished studs and shall conform to the following requirements:

Metric Units

	<u>Shear Connectors</u>	<u>Anchors & Fasteners</u>
Tensile Strength (minimum)	415 Mpa	380 MPa
Yield Strength (minimum)*	345 Mpa	345 MPa
Elongation (minimum)	20% in 50 mm	20% in 50 mm
Reduction of area (minimum)	50 percent	50 percent

*As determined by a 0.2 percent offset method.

English Units

	<u>Shear Connectors</u>	<u>Anchors & Fasteners</u>
Tensile Strength (minimum)	60,000 psi.	55,000 psi.
Yield Strength (minimum)*	50,000 psi	50,000 psi
Elongation (minimum)	20% in 2 Inches	20% in 2 Inches
Reduction of area (minimum)	50 percent	50 percent

*As determined by a 0.2 percent offset method.

Only studs meeting all requirements of AWS D1.1, Part F, with the above modifications, shall be used.

Before any studs will be allowed to be used on a project, the Contractor shall submit to the Engineer the name of the manufacturer and the information required under AWS D1.1, par. 4.23.3 as follows:

1. The stud manufacturer's certification that the studs, as delivered, conform to the applicable requirements of AWS D1.1, par. 4.22 and 4.23.
2. Certified copies of the stud manufacturer's test reports covering the last completed set of inplant quality control mechanical tests, required by AWS D1.1, par. 4.23, for each stock size delivered. These tests shall be made using either finished studs or steel bars for studs of diameters to be furnished under the contract. The quality control tests shall have been made within the six month period before delivery of the studs.

As an alternate, manufacturers may elect to submit the material required under AWS D1.1, par. 4.23.3 to the Department, on a semiannual basis, for inclusion of their materials on the Department's preapproved stud list. The initial submission of the above material shall be accompanied by full geometric data for the stud base(s) and a copy of their respective qualification tests as specified in AWS D1.1 art. 4.27. When a stud is included on the preapproved list, no further submission of test data will be required for each individual project.

711.07 Mattresses. Each shipment of mattresses on a job site shall be accompanied by a certificate which states that the material conforms to the requirements of this specification. The certificate shall be on the manufacturer's letterhead and shall be signed by an officer of the company having legal authority to bind the company.

Mesh openings shall be hexagonal in shape, measuring approximately 63 x 83 mm [2½ x 3¼ inches] and shall be uniform in size. Double twist mesh joints shall be flexible with each pair of wires twisted three half turns (triple twisted) to prevent unraveling. Steel wire and galvanizing shall meet the requirements of ASTM A641M [ASTM A641] and ASTM A90, shall have a Class 3 coating and shall be soft temper. The wire mesh shall have a sufficient elasticity to permit elongation of the mesh equivalent to a minimum of 10 percent of its length.

- (a) Galvanized Mattresses without Polyvinylchloride Coating. The diameter of the steel wire mesh shall be 2.2 mm [0.0866 inches] after galvanizing. The diameter of the selvedge wire, running through all the edges (perimeter wire), shall be 2.7 mm [0.1063 inches] after galvanizing. The diameter of the wire for assembling and lacing the units shall be 2.2 mm [0.0866 inches] after galvanizing. The above wire sizes shall have a tolerance of ± 2.50 percent.
- (b) Polyvinylchloride (PVC) Coated Mattresses. When specified on the plans, all galvanized steel wire shall be coated with a minimum thickness of 0.38 mm [0.015 inches] of gray or green PVC, which shall be suitable to resist the destructive effects of immersion in acidic, salt or polluted water, exposure to ultra violet light and abrasion and retain these characteristics after a period of not less than 3,000 hours when tested in accordance with ASTM G23. The diameter of the steel wire mesh shall be 2.2 mm [0.0866 inches] after galvanization and 2.96 mm [0.1166 inches] overall minimum, core wire plus PVC Coating.

The diameter of the selvedge wire running through all the edges (perimeter wire) shall be 2.67 mm 0.1050 inches after galvanizing and an overall minimum diameter of 3.43 mm [0.1350 inches], core wire plus PVC coating. The diameter of the wire for assembling and lacing the units shall be 2.2 mm [0.0866 inches] after galvanizing and 2.96 mm [0.1166 inches] nominal overall, core wire plus PVC coating. All wire sizes shall have a tolerance of ± 2.50 percent, the thickness of the PVC excluded.

The mesh shall be capable of withstanding the test described below:

An uncut section of mesh 2 m [6 feet] long and a minimum width of 1 m [3 feet], including all selvedge bindings, shall have the ends securely clamped for 1 m [3

feet] along the width of the sample. When the width of the section under test exceeds 1 m [3 feet], the clamps shall be placed in the middle portion of the width and the excess width shall be allowed to fall free on each side of the clamped section. The sample shall then be subjected to sufficient tension to cause 10 percent elongation of the sample section between clamps. After elongation and while clamped as described above (and otherwise unsupported), the section shall be subjected to a load applied to an area of 0.09 m² [1 square foot] located approximately in the center of the sample section between the clamps and in a direction perpendicular to the direction of the tensile force. The sample shall be able to withstand without rupture of any wire or opening of any mesh fastening, an actual load, so applied, equaling or exceeding 2720 kg [6,000 pounds]. The ram head used in test shall be circular with its edges beveled or rounded to prevent cutting the wires.

711.08 Stones for Mattresses. Stones to fill mattresses shall be of clean, hard and durable rock with a minimum dimension of 75 mm [3 inches] in all directions and a maximum dimension of 150 mm [6 inches].

711.09 Neoprene Pads. The neoprene shall be either chloroprene or natural polyisoprene of 50 ±5 Shore A durometer hardness and shall conform to the requirements of Division 2, Section 18.2 and 18.3 of AASHTO Standard Specifications for Highway Bridges, where applicable.

711.10 H-Beam Pile Tips. H-beam pile tips shall be cast steel prefabricated pointed H-shaped sections. The slope forming the point shall not be steeper than 1 3/4:1. Material for plain cast steel pile points shall conform to the requirements of ASTM Specification A27/A27M, Grade 450-240 [Grade 65-35]. Material conforming to ASTM specification A148/A148M Grade 620-415 [Grade 90-60] shall be used for pile points equipped with cutting teeth. The use of pile tips fabricated by welding sections of plate in an "H" configuration will not be allowed.

SECTION 712 -- MISCELLANEOUS HIGHWAY MATERIAL

712.01 Vacant

712.02 Calcium Chloride. Calcium chloride shall conform to the requirements of AASHTO M144 (ASTM D98).

712.03 Portland Cement Concrete for Concrete Curb. Portland cement concrete shall meet the applicable requirements of Section 502 -- Structural Concrete, and shall meet Class A or AA requirements with the following modifications:

- a. Air content shall be 6½% plus or minus 1½%.
- b. Portland cement shall conform to the requirements of AASHTO M85 Designation for Type I, Type II, or Type III.
- c. A minimum 28 day compressive strength of 41.4 MPa [6000 PSI] is required.

All curb shall be cast in steel or concrete forms which will produce a satisfactory surface requiring no further finishing, rubbing or patching after the forms are removed, except for the removal of excess material along the edges. No form joint marks shall be visible when the precast curb units are set in place. Curbs with shrinkage cracks will not be accepted.

Steel reinforcement and dowels shall conform to Section 503 -- Reinforcing Steel.

Dimensions. The precast curb units shall be of the dimensions indicated on the plans and shall be cast in lengths of not less than 1.2 m [four feet] nor greater than 3 m [ten feet]. Random lengths of curb less than 1.2 m [four feet] in length may be obtained by sawing regular precast curb, if the Engineer determines it necessary to meet field conditions. All curb to be set on a radius of 20 m [50 feet] or less shall be precast to fit the curve as required.

When a depressed or modified section of curb is called for on the plans or ordered by the Engineer, for driveways, crossings, closures, transitions or for other reasons, the Contractor shall furnish curbing with the required modifications.

Inlets used at catch basins shall conform to the applicable requirements of Vertical Curb, Type 2 and to the shape, dimensions and details as shown on the Standard Detail plans.

Curing. The units shall be cured either by steam or water for a sufficient length of time for the concrete to obtain the minimum 28 day compressive strength of 41.4 MPa [6000 psi].

- a. Steam Curing: Two to four hours after the concrete has been placed and attained the initial set, the first application of steam shall be made. Forms shall be removed after the units have been cured for 24 hours. The steam shall be 100 percent relative humidity to provide moisture for proper hydration of cement. The steam shall be directly applied onto the concrete. During application of steam, the ambient air temperature of 55 °C [130 °F] is required. When discontinuing the steam application, the ambient temperature shall be decreased at a rate of 20 °C [40 °F] per hour until a temperature of 10 °C [20 °F] above the atmospheric temperature has been attained. The concrete shall not be exposed to temperature below freezing for a minimum of six days after casting.
- b. Water Curing: The units may be water cured by covering with water, saturated material or other acceptable or approved methods that will keep the units moist for a period of five days.

712.04 Stone Curbing and Edging. Stone for curbing and edging shall be approved granite from acceptable sources. The stone shall be hard and durable, predominantly gray in color, free from seams which impair its structural integrity and of smooth splitting character. Natural grain size and color variations characteristic of the source deposit will be permitted. Such natural variations may include bands or clusters of mineral or both of mineral crystallization that do not impair the structural integrity of the curb stone. The dimensions, shape and other details shall be as shown on the plans.

The exposed face of stone curb shall be free from indications of drill holes. Half drill holes not larger than 20 mm [3/4 inch] diameter will be permitted in the arris line in the plane of the back.

- (a) Vertical Curb shall have a top surface sawed or dressed to an approximate true plane with no depression or projection on that surface of over 3 mm [1/8 inch]. The top front arris line shall be pitched straight and true with no variations from a straight line greater than 6 mm [1/4 inch]. The top back arris line shall meet the same requirement except that indentations of a maximum of 9 mm [3/8 inch] will be allowed. There shall be no projection or depression on the back face which would exceed a batter of 1 horizontal on 3 vertical for a distance from the top of 75 mm [3 inches].

The front face shall be at right angles to the top and shall be smooth split and have no projections greater than 25 mm [1 inch] or depressions greater than 13 mm [1/2 inch], measured from the vertical plane of the face through the top arris line for a distance down from the top of 200 mm [8 inches]. The remainder of the face shall have no projections or depressions greater than 25 mm [1 inch] from the plane of the face.

The ends of the curb shall be approximately square with the planes of the top, back and face and so finished that when the sections are placed end to end with the required minimum spacing of 6 mm [1/4 inch] no more than 16 mm [5/8 inch] space shall show in the joint for the full width of the top surface and for the entire exposed front face. The remainder of the end may extend back no more than 200 mm [8 inches] from the plane of the joint.

Drill holes through the curb will be allowed providing they are at least 225 mm [9 inches] below the top and are mortared full with portland cement mortar before placing the stone.

- (b) Miscellaneous Stone Curb. When a depressed or modified section of curb is called for on the plans or ordered by the Engineer, for driveways, crossings, closures, transitions or for other reasons, the Contractor shall furnish curbing with the required modifications.
- (c) Curb Inlets. Inlets used at catch basins shall conform to the applicable requirements of Vertical Curb, Type 1 and to the shape, dimensions and details as shown on the Standard Detail plans.
- (d) Dimensions. The stone curb units shall be of the dimensions indicated on the plans and shall be cut in lengths of not less than 1.2 m [four feet] nor greater than 3 m ten feet. Random lengths of curb less than 1.2 m [four feet] in length may be obtained if the Engineer determines it necessary to meet field conditions. All curb to be set on a radius of 20 m [60 feet] or less shall be cut to fit the curve as required.

(e) Vertical Bridge Curb shall conform to the requirements above, except as indicated on the plans and as follows:

1. The back face of the curb stones shall have no projections or depressions greater than 25 mm [1 inch], measured from the vertical plane of the back face through the arris or pitch line down to the bottom of the stone. The front face shall be finished as required for Vertical Curb, Type 1, except that it shall be finished the full distance down on the face. Bottoms of curb stones shall be approximately parallel to the top and sawed or dressed to lay with a bedding of approximately 25 mm [1 inch] for the full length of the stone.
2. Anchor holes shall be provided in the back of the stones, pitched down as shown on the plan, a maximum of 450 mm [18 inches] from each end of the stone and spaced horizontally at a maximum of 1200 mm [4 feet] apart. A minimum of 2 anchor holes shall be provided in each stone.
3. The ends of stones at expansion joints between spans and at ends of the bridge shall be cut to present a vertical face when set in position, beveled to the skew angle, if any and the entire end finished in the same manner as the top.
4. The exposed edges of the stones at intermediate joints shall be trimmed square with the planes of the top and front face so that a neat, parallel joint, free from drill holes is formed between the stones. Length of stones shall be so scheduled that joints will be uniform in width along any run of curb. Joints shall be 13 mm [$\frac{1}{2}$ inch], plus or minus 3 mm [$\frac{1}{8}$ inch]. A joint shall be provided at each curb and sidewalk contraction joint of the bridge.
5. Stones set transversely at ends of a bridge, when the grade exceeds 2 percent, shall have the top beveled to fit the grade of the bridge.
6. Mortar for bedding shall be composed of 1 part portland cement and 2 parts sand with sufficient water to form a workable mix. Cement, sand and water shall conform to Section 502 -- Structural Concrete.
7. Mortar for pointing shall be composed of equal parts sand and portland cement with sufficient water to form a workable mix and shall conform to Section 502 -- Structural Concrete.
8. Portland cement grout shall be made the same as mortar for pointing, except that consistency shall be such that it will flow readily.

(f) Curb Type 5. The exposed face shall be smooth split to an approximate true plane having no projections or depressions which will allow over 25 mm [1 inch] to

show between a 600 mm [2 foot] straightedge and the face when the straightedge is placed as closely as possible on any part of the face. Half drill holes not more than 75 mm [3 inches] in length and 20 mm [3/4 inch] in diameter will be permitted along the bottom. The arris line, top front shall be straight and true with no variation from a straight line greater than 3 mm [1/8 inch]. The arris lines at the bottom of the face shall be straight and true so that not over 25 mm [1 inch] shall show between the stone and a straightedge for the full length of the stone. The ends shall be square to the length at the face and so finished that when the stones are placed end to end, no space more than 40 mm [1½ inches] will show in the joint for the width of the face.

When Curbing Type 5 is required on a curve, the pieces shall be shaped as described in the table on the Standard Detail plans.

712.05 Preformed Plastic. Type of Material. This section covers reflectorized plastic materials performed into rolls or ribbons of various lengths, pliability, and widths suitable for use as reflecting pavement markings on Portland cement concrete or bituminous pavement.

General Characteristics. The preformed marking materials shall consist of white or yellow films with pigments selected and blended to provide the appropriate highway colors for traffic markings. Glass or ceramic beads shall be incorporated to provide immediate and continuing retroreflection. The size, quality, and refractive index of the beads shall be such that the performance requirements of this specification shall be met.

The edges of the preformed material shall be clean cut and true. The preformed plastic material may be supplied complete with a precoated, factory applied adhesive for immediate pavement application without the use of heat, solvent, or other types of adhesive for immediate pavement application without the use of heat, solvent, or other types of adhesive operations or it may be furnished with separate adhesives as recommended by the manufacturer.

The affixed material shall be capable of molding itself to the pavement contoured by the action of traffic and maintain its original dimensions and placement under normal traffic conditions at the pavement temperatures which could occur within the State. After application, the markings shall be immediately ready for traffic.

Physical requirements - Color. Pigments shall be selected and blended to conform to standard highway colors throughout the expected life of the material. When tested by Federal Test Method Standard 141 Method 4232, the white shall be no darker than Color Number 37778 of Federal Standard Number 595 and the yellow shall conform to Color Number 33538 of Federal Standard Number 595 (Highway Yellow Color PR#1).

Retroreflectivity. The retroreflective preformed film shall have a layer of reflective spheres bonded to the top surface. The white and yellow film shall have the following initial minimum retroreflectance values at 0.2° and 0.5° observation angles and 86° entrance angle as measured in accordance with the photometric testing procedures of ASTM D4061.

Retroreflectance values shall be expressed as specific luminance in millicandelas per square meter per lux ($\text{mcdm}^2\text{lx}^{-1}$) [millicandelas per square foot per foot candle ($\text{mcd ft}^2\text{fc}^{-1}$)]

	White	Yellow
Observation Angle	0.2° 0.5°	0.2° 0.5°
SL[mcdm ² lx ¹] [mcd ft ² fc ¹]	550 380	410 250

The test distance shall be 15 m [50 feet] and the sample size a 600 x 750 mm [2.0 x 2.5 foot] rectangle. The angular aperture of both the photoreceptor and light projector shall be 10 minutes of arc. The reference center of the sample and the reference axis shall be taken perpendicular to the test sample.

Bead Retention. When tested with a 50 mm by 150 mm 2 inch by 6 inch sample bent over a 13 mm ½ inch diameter mandrel with the 50 mm [2 inch] dimension perpendicular to the mandrel axis, microscopic examination of the arc on the mandrel shall show no more than 10 percent of the beads are entrapped in the binder and less than 40 percent of the surface of the bead.

Application. The preformed plastic material shall be capable of application to non-defective pavement surfaces that are dry and free from dirt or other foreign matter. For normal application, the pavement temperature should be at least 15 °C [60 °F] and rising.

Special instructions should be supplied by the vendor for application to be made at pavement temperatures below 15 °C [60 °F]. Application shall be according to manufacturer's recommended procedures. Plastic pavement marking materials shall only be applied to surfaces with temperatures within the range specified by the manufacturer for optimum adhesion.

Adhesive, activators or special coatings for various types of pavement surfaces shall be provided with the preformed plastic material. Detailed information must be supplied with the material outlining required application procedures for such adhesives, activators or special coating.

Preformed plastics shall be capable of being applied to new asphalt pavement immediately prior to the final rolling of the new surface and of being rolled into place with conventional pavement and highway rollers. The plastic material and adhesives used in such applications shall be of the type that water used on the roller to prevent asphalt pickup shall not be harmful to the successful application of the plastic.

Special equipment necessary for the successful installation of any preformed plastic material shall be available from the manufacturer of the plastic material on a lease, loan or purchase basis.

Longitudinal lines shall be offset at least 50 mm [2 inches] from construction joints of Portland cement concrete pavement. When directed by the Engineer, opening of 150 mm [6 inch] lengths shall be left at 6 m [20 foot] intervals in edge lines not inlaid into the pavement surface that are placed on the inside of superelevated curves so as to prevent the ponding of water on the pavement surface.

712.06 Precast Concrete Units. Precast concrete units shall conform to the plan dimensions and shall meet the requirements of ASTM C478M [ASTM C478] except as modified below.

Cement shall conform to Subsection 701. An approved air entraining admixture shall be added to obtain the required air content.

Aggregates shall meet the quality requirements of Subsection 703.01 and Subsection 703.02 except that limitations on grading and the fineness modulus may be omitted.

The concrete mix design shall be approved by the Department. Concrete shall contain 6 percent air content, plus or minus 1½ percent tolerance. All concrete shall develop a minimum compressive strength of 20 MPa [3000 pounds per square inch] in 7 days or 30 MPa [4000 pounds per square inch] in 28 days.

712.07 Tops, and Traps. These metal units shall conform to the plan dimensions and to the following specification requirements for the designated materials.

Gray iron castings shall conform to the requirements of AASHTO M105, Class 30, unless otherwise designated.

Carbon steel castings shall conform to the requirements of AASHTO M103/M103M. Grade shall be 450-240 [65-35] unless otherwise designated.

Structural steel shall conform to the requirements of AASHTO M183/M183M or ASTM A283/A283M, Grade B or better. Galvanizing, where specified for these units, shall conform to the requirements of AASHTO M111.

712.08 Corrugated Metal Units. The units shall conform to plan dimensions and the metal to AASHTO M36/M36M. Bituminous coating, when specified, shall conform to AASHTO M190 Type A.

712.09 Catch Basin and Manhole Steps. Steps for catch basins and for manholes shall conform to ASTM C478M [ASTM C478], Section 13 for either of the following material:

- (a) Aluminum steps-ASTM B221M, [ASTM B211] Alloy 6061-T6 or 6005-T5.
- (b) Reinforced plastic steps Steel reinforcing bar with injection molded plastic coating copolymer polypropylene. Polypropylene shall conform to ASTM D 4101.

712.10 to 712.22 Vacant

712.23 Flashing Lights. Flashing Lights shall be power operated or battery operated as specified.

- (a) Power operated flashing lights shall consist of housing, adapters, lamps, sockets, reflectors, lens, hoods and other necessary equipment designed to give clearly

visible signal indications within an angle of at least 45 degrees and from 3 to 90 m [10 to 300 feet] under all light and atmospheric conditions.

Two circuit flasher controllers with a two-circuit filter capable of providing alternate flashing operations at the rate of not less than 50 nor more than 60 flashes per minute shall be provided.

The lamps shall be 650 lumens, 120 volt traffic signal lamps with sockets constructed to properly focus and hold the lamp firmly in position.

The housing shall have a rotatable sun visor not less than 175 mm [7 inches] in length designed to shield the lens.

Reflectors shall be of such design that light from a properly focused lamp will reflect the light rays parallel. Reflectors shall have a maximum diameter at the point of contact with the lens of approximately 200 mm [8 inches].

The lens shall consist of a round one-piece convex amber material which, when mounted, shall have a visible diameter of approximately 200 mm [8 inches]. They shall distribute light and not diffuse it. The distribution of the light shall be asymmetrical in a downward direction. The light distribution of the lens shall not be uniform, but shall consist of a small high intensity portion with narrow distribution for long distance throw and a larger low intensity portion with wide distribution for short distance throw. Lenses shall be marked to indicate the top and bottom of the lens.

- (b) Battery operated flashing lights shall be self-illuminated by an electric lamp behind the lens. These lights shall also be externally illuminated by reflex-reflective elements built into the lens to enable it to be seen by reflex-reflection of the light from the headlights of oncoming traffic. The batteries must be entirely enclosed in a case. The case must be secured by a locking device. The light shall have a flash rate of not less than 50 nor more than 60 flashes per minute from minus 30 °C [minus 20 °F] to plus 65 °C [plus 150 °F]. The light shall have an on time of not less than 10 percent of the flash cycle. The light beam projected upon a surface perpendicular to the axis of the light beam shall produce a lighted rectangular projection whose minimum horizontal dimension shall be 5 degrees each side of the horizontal axis. The effective intensity shall not have an initial value greater than 15.0 candelas or drop below 4.0 candelas during the first 336 hours of continuous flashing. The illuminated lense shall appear to be uniformly bright over its entire illuminated surface when viewed from any point within an angle of 9 degrees each side of the vertical axis and 5 degrees each side of the horizontal axis. The lens shall not be less than 175 mm [7 inches] in diameter including a reflex-reflector ring of 13 mm [½ inch] minimum width around the periphery. The lens shall be yellow in color and have a minimum relative luminous transmittance of 0.440 with a luminance of 2854° Kelvin. The lens shall be one piece construction. The lens material shall be plastic and meet the luminous transmission requirements of this specification. The case containing the batteries

and circuitry shall be constructed of a material capable of withstanding abuse equal to or greater than 1.21 mm thick steel [No. 18 U.S. Standard Gage Steel]. The housing and the lens frame, if of metal shall be properly cleaned, degreased and pretreated to promote adhesion. It shall be given one or more coats of enamel which, when dry shall completely obscure the metal. The enamel coating shall be of such quality that when the coated case is struck a light blow with a sharp tool, the paint will not chip or crack and if scratched with a knife will not powder. The case shall be so constructed and closed as to exclude moisture that would affect the proper operation of light. The case shall have a weep hole to allow the escape of moisture from condensation. Photoelectric controls, if provided, shall keep the light operating whenever the ambient light falls below 215 lx [20 foot candles]. Each light shall be plainly marked as to the manufacturer's name and model number.

If required by the Engineer, certification as to conformance to these specifications shall be furnished based on results of tests made by an independent testing laboratory. All lights are subject to random inspection and testing. All necessary random samples shall be provided to the Engineer upon request without cost to the Department. All such samples shall be returned to the Contractor upon completion of the tests.

712.24 through 712.31 Vacant

712.32 Copper Tubing. Copper tubing and fittings shall conform to the requirements of ASTM B88M Type A [ASTM B88, Type K] or better.

712.33 Non-metallic Pipe, Flexible. Non-metallic pipe and pipe fittings shall be acceptable flexible pipe manufactured from virgin polyethylene polymer suitable for transmitting liquids intended for human or animal consumption.

712.34 Non-metallic Pipe, Rigid. Non-metallic pipe shall be Schedule 40 polyvinylchloride (PVC) that meets the requirement of ASTM D1785. Fittings shall be of the same material.

712.341 Metallic Pipe. Metallic pipe shall be ANSI, Standard B36.10, Schedule 40 steel pipe conforming to the requirements of ASTM A53 Types E or S, Grade B. End plates shall be steel conforming to ASTM A36/A36M.

Both the sleeve and end plates shall be hot dip galvanized. Pipe sleeve splices shall be welded splices with full penetration weld before galvanizing.

712.35 Epoxy Resin. Epoxy resin for grouting or sealing shall consist of a mineral filled thixotropic, flexible epoxy resin having a pot life of approximately one hour at 10°C [50°F]. The grout shall be an approved product suitable for cementing steel dowels into the preformed holes of curb inlets and adjacent curbing. The sealant shall be an approved product, light gray in color and suitable for coating the surface.

712.36 Bituminous Curb. The asphalt cement for bituminous curb shall be of the grade required for the wearing course, or shall be Viscosity Grade AC-20 meeting the current requirements of Subsection 702.01 Asphalt Cement. The aggregate shall conform to the requirements of Subsection 703.07. The coarse aggregate portion retained on the 2.36 mm [No. 8] sieve may be either crushed rock or crushed gravel.

The mineral constituents of the bituminous mixture shall be sized and graded and combined in a composite blend that will produce a stable durable curbing with an acceptable texture.

Bituminous material for curb shall meet the requirements of Section 403 -- Hot Bituminous Pavement.

712.37 Precast Concrete Slab. Portland cement concrete for precast slabs shall meet the requirements of Section 502 -- Structural Concrete, Class A.

The slabs shall be precast to the dimension shown on the plans and cross section and in accordance with the Standard Detail plans for Concrete Sidewalk Slab. The surface shall be finished with a float finish in accordance with Subsection 502.14(c). Lift devices of sufficient strength to hold the slab while suspended from cables shall be cast into the top or back of the slab.

712.38 Stone Slab. Stone slabs shall be of granite from an acceptable source, hard, durable, predominantly gray in color, free from seams which impair the structural integrity and be of smooth splitting character. Natural color variations characteristic of the deposit will be permitted. Exposed surfaces shall be free from drill holes or indications of drill holes. The granite slabs in any one section of backslope must be all the same finish.

The granite slabs shall be scabble dressed or sawed to an approximately true plane having no projections or depressions over 13 mm [$\frac{1}{2}$ inch] under a 600 mm [2 foot] straightedge or over 25 mm [1 inch] under a 1200 mm [4 foot] straightedge. The arris at the intersection of the top surface and exposed front face shall be pitched so that the arris line is uniform throughout the length of the installed slabs. The sides shall be square to the exposed face unless the slabs are to be set on a radius or other special condition which requires that the joints be cut to fit, but in any case shall be so finished that when the stones are placed side by side no space more than 20 mm [$\frac{3}{4}$ inch] shall show in the joint for the full exposed height.

Liftpin holes in all sides will be allowed except on the exposed face.

SECTION 713 -- STRUCTURAL STEEL AND RELATED MATERIAL

713.01 Structural Steel.

- (a) Structural Steel shall conform to one or more of the following specifications as designated on the plans:

1. AASHTO M183/M183M (ASTM A36/A36M) Structural Steel.
2. ASTM A242/A242M High-Strength Low-Alloy Structural Steel.
3. AASHTO M244/M244M (ASTM A514/A514M) High Yield Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.
4. ASTM A570/A570M Hot-rolled Carbon Steel Sheet and Strip, Structural Quality. (Grade 36 or Grade 50, Copper-bearing).
5. AASHTO M223/M223M (ASTM A572/A572M) High Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality Grade 345 [Grade 50] only.
6. AASHTO M222/M222M (ASTM A588/A588M) High Strength Low-Alloy Structural Steel with 345 MPa [50,000 psi]. Minimum Yield Point, to 100 mm [4 inches] thick.
7. AASHTO M270/M270M (ASTM A709/A709M) Structural Steel for Bridges, Grades 250, 345, 345W, 485W and 690 [Grades 36, 50, 50W, 70W, and 100]. The specified grades are the equivalent, respectively, of ASTM A36/A36M., ASTM A572/A572M, ASTM A588/A588M, ASTM A852/A852M and ASTM A514/A514M.
8. ASTM A852/A852M Quenched and Tempered Low - Alloy Structural Steel Plate with 485 MPa [70 ksi] Minimum Yield Strength to 100 mm [4 inches] thick.

METRIC UNITS
TABLE A -- NOTCH TOUGHNESS REQUIREMENTS

Steel	Thickness	Charpy V-notch Impact Test
AASHTO M183/M183M (ASTM A36/A36M)	:Up to 100 mm	:Min.20 Nm @ 4°C
AASHTO M270/M270M (ASTM A709/A709M), GR. 250		
AASHTO M244/M244M (ASTM A514/A514M)	:Up to 100 mm mechanically fastened	:Min.30 Nm @ -18°C
AASHTO M270/M270M (ASTM A709/A709M),GR. 690	:Up to 60 mm welded	:Min.30 Nm @ -18 °C
	:Over 60 mm to 100 mm welded	:Min.47 Nm @ -18 °C
AASHTO M223/M223M (ASTM A572/A572M)*	:Up to 100 mm mechanically fastened	:
AASHTO M270/270M (ASTM A709/A709M)GR. 345	:	:Min.20 Nm @ 4°C
	:Up to 50 mm welded	:
AASHTO M222/M22M (ASTM A588/A588M)	:Up to 100 mm mechanically fastened	:Min.20 Nm @ 4 °C
AASHTO M270/M270M (ASTM A709/A709M)GR.345W*	:Up to 50 mm welded	:Min.20 Nm @ 4 °C
	:Over 50 to 100 mm welded	:Min.27 Nm @ 4 °C
ASTM A852/A852M	:Up to 100 mm mechanically fastened	:Min.27 Nm @ -7 °C
AASHTO M270/M270M (ASTM A709/A709M)Gr.485W**	:Up to 60 mm welded	:Min.27 Nm @ -7 °C
	:Over 60 mm 4" welded	:Min.30 Nm @ -7 °C

*If the yield point for the material exceeds 450 MPa, the temperature for the CVN value for acceptability shall be reduced by 9 °C for each increment of 69 MPa., or fraction thereof above 450 MPa.

**If the yield point for the material exceeds 585 MPa, the temperature for the CVN value for acceptability shall be reduced by 1.2 °C for each increment of 10 MPa, or fraction thereof above 585 MPa.

(b) In addition to the requirements of the applicable specifications, Notch Toughness Requirements, as specified in Table A, are mandatory for main load- carrying members except as otherwise indicated on the plans. For purposes of this specification main load-carrying members shall be those parts of a structure carrying calculated stresses, including but not limited to webs and flanges of welded plate girders, rolled shapes used as girders, floorbeams and stringers and all splice material for such members other than filler plates.

(c) Corrosion resistant steel shall conform to the requirements of M222/M222M (ASTM A588/A588M) AASHTO M270/M270M (ASTM A709/A709M) Grade 345W or Grade 485W, or ASTM A852/A852M.

High Strength Bolts for use with unpainted corrosion resistant steel shall conform to AASHTO M164M (ASTM A325M) [AASHTO M164 (ASTM A325)], Type 3. All other bolts and/or fasteners which will remain in the finished structure shall be of material having the same weathering characteristics as the corrosion resistant base metal.

Steel conforming to ASTM A242/A242M may be used as an alternate to either AASHTO M222/M222M (ASTM A588/ A588M) or AASHTO M270/M270M (ASTM A709/A709M), Grade 345W for members other than main stress carrying members which do not require welding.

- (d) Impact test sampling and testing procedures shall be in accordance with ASTM A673/A673M. For steels with a specified yield strength of 345 MPa or less, test frequency H shall be used. For steels with a specified yield strength over 345 MPa, test frequency "P" shall be used.
- (e) Submission of test reports for all tests required under the applicable specifications and this specification is mandatory.

ENGLISH UNITS
TABLE A -- NOTCH TOUGHNESS REQUIREMENTS

Steel	Thickness-Inches	Charpy V-notch Impact Test
AASHTO M183(ASTM A36)	:Up to 4"	:Min. 15 ft. lb. @ 40 °F
AASHTO M270	:	:
(ASTM A709),GR. 36	:	:
AASHTO M244 (ASTM A514)	: Up to 4" mechanically fastened	:Min. 25 ft. lb. @ 0 °F
	:Up to 2½" welded	:Min. 25 ft. lb. @ 0 °F
AASHTO M270	:Over 2½ to 4" welded	:Min. 35 ft. lb. @ 0 °F
(ASTM A709), GR. 100	:	:
AASHTO M223(ASTM A572)*	:Up to 4" mechanically fastened	:Min. 15 ft. lb. @ 40 °F
AASHTO M270	:	:
(ASTM A709),GR. 50*	:Up to 2" welded	:Min. 15 ft. lb. @ 40 °F
AASHTO M222(ASTM A588)*	:Up to 4" mechanically fastened	:Min. 15 ft. lb. @ 40 °F
AASHTO M270	:Up to 2" welded	:Min. 15 ft. lb. @ 40 °F
(ASTM A709),GR. 50W*	:Over 2" to 4" welded	:Min. 20 ft. lb. @ 40 °F
ASTM A852**	:Up to 4" mechanically fastened	:Min. 20 ft. lb. @ 20 °F
AASHTO M270	:Up to 2½" welded	:Min. 20 ft. lb. @ 20 °F
(ASTM A709), GR. 70W**	:Over 2½ to 4" welded	:Min. 25 ft. lb. @ 20 °F

*If the yield point for the material exceeds 65 ksi., the temperature for the CVN value for acceptability shall be reduced by 15°F for each increment of 10 ksi., or fraction thereof above 65 ksi.

**If the yield point for the material exceeds 85 ksi., the temperature for the CVN value for acceptability shall be reduced by 15°F for each increment of 10 ksi., or fraction thereof above 85 ksi.

- (b) In addition to the requirements of the applicable specifications, Notch Toughness Requirements, as specified in Table A, are mandatory for main load-carrying members except as otherwise indicated on the plans. For purposes of this specification main load-carrying members shall be those parts of a structure carrying calculated stresses, including but not limited to webs and flanges of welded plate girders, rolled shapes used as girders, floorbeams and stringers and all splice material for such members other than filler plates.
- (c) Corrosion resistant steel shall conform to the requirements of AASHTO M222 (ASTM A588), AASHTO M270 (ASTM A709) Grade 50W or 70W, or ASTM A852.

High Strength Bolts for use with unpainted corrosion resistant steel shall conform to AASHTO M164 (ASTM A325), Type 3. All other bolts and/or fasteners which will remain in the finished structure shall be of material having the same weathering characteristics as the corrosion resistant base metal.

Steel conforming to ASTM A242 may be used as an alternate to either AASHTO M222 (ASTM A588) or AASHTO M270 (ASTM A709), Grade 50W for members other than main stress carrying members which do not require welding.

- (d) Impact test sampling and testing procedures shall be in accordance with ASTM A673. For steels with a specified yield strength of 351 MPa [50 ksi] or less, test frequency H shall be used. For steels with a specified yield strength over 50 ksi, test frequency "P" shall be used.
- (e) Submission of test reports for all tests required under the applicable specifications and this specification is mandatory.

713.02 High Strength Bolts. Bolts, shall conform to the requirements of AASHTO M164M (ASTM A325M) [AASHTO M164 (ASTM A325)], Type 1 or 3 and the requirements of this specification, Type 2 bolts will not be allowed for use under these specifications.

Type 1 bolts shall be supplied for all structures except that Type 3 bolts shall be supplied for all structures utilizing unpainted AASHTO M222/M222M (ASTM A588/A588M) steel.

Except as amended by the other requirements of this subsection, nuts for use with the above specified bolts shall conform to the requirements of Subsection 1.6 of AASHTO M164M (ASTM A325M) [AASHTO M164 (ASTM A325)].

Bolt and nut dimensions shall conform to the requirements for Heavy Hexagon Structural Bolts and Heavy Semifinished Hexagon Nuts as specified in ANSI Standard B18.2.7 M and B18.2.6M [B18.2.1 and B18.2.2] respectively and as summarized in Table 1.

Both circular and beveled washers for use with the above specified bolts shall conform to the requirements of AASHTO M293 (ASTM F436M) [AASHTO M293 (ASTM F436)] and the requirements of this specification. Washer dimensions shall conform to those tabulated in Table

2. Where required, washers may be clipped on one side to a point not closer than 7/8 of the nominal bolt diameter from the center of the washer.

Direct Tension Indicators (DTI'S) shall conform to the requirements of ASTM F959M/F959 and the requirements of this specification.

Bolts, nuts, and washers, specified to be galvanized may be galvanized by either hot dip galvanizing to the requirements of AASHTO M232 (ASTM A153) Class C or mechanically galvanized to the requirements of AASHTO M298 (ASTM B695) Class 50, Type I. Galvanized nuts shall be overlapped to the minimum required for the fastener assembly, and shall be lubricated. Overlapping shall not exceed 0.53 mm [0.021 inch] diametrically for nuts 25 mm [1 inch] diameter and smaller and 0.79 mm [0.031 inch], for nuts larger than 25 mm [1 inch] diameter.

DTI's for use with painted steel shall have a plain "as fabricated" finish, DTI's for use with unpainted "weathering" steel shall have a brown baked epoxy finish, and DTI's for use with galvanized steel, zinc-metallized steel and steel coated with a zinc-rich primer shall be galvanized.

All fasteners (bolts and nuts), whether black or galvanized, shall be lubricated with a suitable lubricant after all manufacturing operations, including galvanizing if required, are complete. Galvanized nuts shall be lubricated with a lubricant containing a visible dye, in order that the presence of the lubricant can be visually checked at the time of field installation.

METRIC UNITS

TABLE 1 - BOLT DIMENSIONS (millimeters)

Nominal bolt diameter & thread pitch	Width across flats(Max)	Height of head (Mean)	Thread length		Add to grip for bolt length ¹
			<100	>100	
M16 x 2	27.00	10.00	31	38	26
M20 x 2.5	34.00	12.50	36	43	32
M22 x 2.5	36.00	14.00	38	45	35
M24 x 3	41.00	15.00	41	48	36
M27 x 3	46.00	17.00	44	51	39
M30 x 3.5	50.00	18.70	49	56	42
M36 x 4	60.00	22.50	56	63	48

¹ Allowance for one circular washer is included.

Notes: Grip is the total thickness of the material to be connected, exclusive of washers. Bolt lengths shall be determined by adding the values given in the 5th column of Table 1 to the grip and if necessary, adjusting upwards to the next available increment. When using beveled washers, 4 mm shall be added to the grip for one washer and 12 mm for two.

METRIC UNITS

Nut Dimensions (Millimeters)

Nominal bolt diameter & thread pitch	Width across flats (Max.)	Thickness (Mean)
M16 x 2	27.00	16.75

M20 x 2.5	34.00	20.05
M22 x 2.5	36.00	22.95
M24 x 3	41.00	23.55
M27 x 3	46.00	26.95
M30 x 3.5	50.00	29.9
M36 x 4	60.00	35.80

ENGLISH UNITS
TABLE 1 - BOLT AND NUT DIMENSIONS (inches)

Bolt					Nut	
Nominal bolt size	Width across Flats	Height of head	Thread length	Add to grip for bolt length ¹	Width across	Height
1/2	7/8	5/16	1	13/16	7/8	31/64
5/8	1 1/16	25/64	1 1/4	1 1/16	1 1/16	39/64
3/4	1 1/4	15/32	1 3/8	1 3/16	1 1/4	47/64
7/8	1 7/16	35/64	1 1/2	1 5/16	1 7/16	55/64
1	1 5/8	39/64	1 3/4	1 7/16	1 5/8	63/64
1 1/8	1 13/16	11/16	2	1 11/16	1 13/16	1 7/64
1 1/4	2	25/32	2	1 13/16	2	1 7/32
1 3/8	2 3/16	27/32	2 1/4	1 15/16	2 3/16	1 11/32
1 1/2	2 3/8	15/16	2 1/4	2 1/16	2 3/8	1 15/32

¹ Allowance for one circular washer is included.

Table 1 Notes:

Grip is the total thickness of material to be connected, exclusive of washers. Bolt lengths shall be determined by adding the values given in the 5th column of Table 1 to the grip and if necessary, adjusting upwards to next 1/4 inch increment.

When using beveled washers 1/8 inch shall be added to the grip for one washer and 7/16 inch for two. Dimensions listed in the table shall be governed by tolerances as specified in ANSI B18.2.1. and B18.2.2.

METRIC UNITS

TABLE -2 WASHER DIMENSIONS (millimeters)

Circular Washers							Beveled Washers					
Nom. Washer Size	Outside Diameter	Diameter of Hole	Thick.				Inside Diameter	Mean Thickness	Slope taper			
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	thickness	
16	34.0	32.4	18.4	18.0	4.6	3.1	18.4	18.0	8.5	7.5	1:6	
20	42.0	40.4	22.5	22.0	4.6	3.1	22.5	22.0	8.5	7.5	1:6	
22	44.0	42.4	24.5	24.0	4.6	3.4	24.5	24.0	8.5	7.5	1:6	
24	50.0	48.4	26.5	26.0	4.6	3.4	26.5	26.0	8.5	7.5	1:6	
27	56.0	54.1	30.5	30.0	4.6	3.4	30.5	30.0	8.5	7.5	1:6	
30	60.0	58.1	33.6	33.0	4.6	3.4	33.6	33.0	8.5	7.5	1:6	
36	72.0	70.1	39.6	39.0	4.6	3.4	39.6	39.0	8.5	7.5	1:6	

ENGLISH UNITS

TABLE 2 - WASHER DIMENSIONS (inches)

Circular Washers							Square or Rectangular Beveled Washers for American Beams and Channels					
Bolt Size	Nominal Outside Diameter ¹	Nominal Diam of Hole	Thickness	Minimum	Mean	Slope or taper						
D			Min.Max.	side dim.	thickness	in thickness						
1/2	1 1/16	17/32	.097 .177	1 3/4	5/16	1:6						
5/8	1 5/16	21/32	.122 .177	1 3/4	5/16	1:6						
3/4	1 15/32	13/16	.122 .177	1 3/4	5/16	1:6						
7/8	1 3/4	15/16	.136 .177	1 3/4	5/16	1:6						
1	2	1 1/16	.136 .177	1 3/4	5/16	1:6						
1 1/8	2 1/4	1 1/4	.136 .177	2 1/4	5/16	1:6						
1 1/4	2 1/2	1 3/8	.136 .177	2 1/4	5/16	1:6						
1 3/8	2 3/4	1 1/2	.136 .177	2 1/4	5/16	1:6						
1 1/2	3	1 5/8	.136 .177	2 1/4	5/15	1:6						

¹May be exceeded by 1/4 inch.

For each lot of bolts, nuts, washers and DTI'S shipped to the end user (i.e. Contractor, MDOT, etc.) the supplier shall perform or cause to be performed the applicable tests, tabulated in Table 3 - Test Schedule. The minimum number of tests for bolts, as well as for nuts and washers for each shipping lot shall be as specified in AASHTO M164M (ASTM A325M) [AASHTO M164 (ASTM A325) par. 9.3.4. Testing frequency for DTI's shall be as specified in ASTM F959/F959M, Section 10.

TABLE 3 - TEST SCHEDULE

Bolts	Tensile Strength(Wedge Test)	ASTM F606M [ASTM F606] par. 3.5.1
	Proof Load(Length Mst.)	ASTM F606M [ASTM F606] par. 3.2.3
	Hardness	ASTM F606M [ASTM F606] par. 3.1
	Coating	ASTM A153M par. 8.2.2 or ASTM B695M par. 8.3
Nuts	Proof Load	ASTM F606M [ASTM F606] par. 4.2
	Hardness (Threaded Nut)	ASTM F606M [ASTM F606] par. 4.1
	Coating Thickness	ASTM A153 par. 8.2.2 or ASTM B695 par. 8.3
Washers	Hardness	ASTM F606M [ASTM F606] par. 5.1 or 5.2
	Coating Thickness	ASTM A153 par. 8.2.2.or ASTM B695 par. 8.3
DTI'S	Coating Thickness	ASTM B695 par. 8.3
	Compression Load	ASTM F959 par. 12.1

The results of the above tests shall meet or exceed the requirements of the applicable AASHTO or ASTM Specification, except that bolts shall have a maximum tensile strength of 1035 MPa [150 Kips per square inch] for bolts 25 mm [1 inch] or less in diameter and 825 MPa [120 Kips per square inch] for bolts over 25 mm [1 inch] in diameter and shall have a hardness not exceeding 34 HRC.

Additionally, high strength fastener assemblies, both black (uncoated) and galvanized, shall be subjected to a rotational capacity test as specified in AASHTO M164M (ASTM A325M) [AASHTO M164 (ASTM A325)] and as modified below. The test shall be conducted using a Skidmore-Wilhelm or equivalent tension measuring device, except as specified under (g) below. The tested fastener assemblies shall meet the following requirements:

- (a) A fastener assembly shall consist of a bolt and matching nut and washer, all taken from the same shipment.
- (b) From a snug-tight condition (10 percent of the specified proof load), tighten the fastener assembly to the Minimum Required Bolt Tension specified in Table 1 of Section 504 using a calibrated manual torque wrench.
- (c) Record the torque required to reach the above tension. Torque must be measured with the nut in motion.
- (d) Further tighten the fastener assembly to reach the total rotation (from the snug-tight condition) specified below:

Length Up to and including 4 diameters 2/3 Turn (240 degrees)

Length over 4 diameters through 8 diameters 1 Turn (360 degrees)

Length over 8 diameters 1 1/3 Turn (480 degrees)

and, following this, inspect the fastener assembly as specified under (i).

- (e) During stage (d) of the test, the maximum recorded tension shall be equal to or exceed 1.15 times the Required Minimum Bolt Tension as specified in Table 1 of Section 504. (Note: The maximum tension achieved during stage (d) is not necessarily the final tension reached at the end of stage (d).
- (f) The torque measured during stage (b), to produce the Required Minimum Bolt Tension specified in Table 1 of Section 504, shall not exceed the value obtained by the following equation.

Torque 0.25 PD

Where: Torque = Measured Torque N•m [foot pounds]

P = Measured Bolt Tension N [Pounds]

D = Nominal Diameter m [feet]

- (g) Bolts which are too short to be assembled in the tension measuring device shall be tested in a steel joint. Use a torque wrench to bring the fastener assembly from the snug-tight condition to the rotation listed below and record the torque required to reach that rotation while the nut is in motion.

Length Up to and 1/3 Turn (120 degrees)
including 4 diameters

Length over 4 diameters 1/2 Turn (180 degrees through 8 diameters)

Length over 8 diameters 2/3 Turn (240 degrees)

- (h) The torque thus determined shall not exceed the maximum computed torque requirement specified under (f) above, computed assuming the Measured Bolt Tension as 1.15 times the Required Minimum Bolt Tension.
- (i) Further tighten the fastener assembly to the rotation specified under (d) above, and following this, loosen and remove the nut and examine the threads on the nut and the bolt. If any evidence is found of torsional failure of the bolt, or shear failure, or stripping of the threads of either the bolt or the nut, the assembly shall be considered as having failed the test.
- (k) Testing frequency to be used by the bolt supplier shall be as specified in AASHTO M164M (ASTM A325M) [AASHTO M164 (ASTM A325)], Par. 9.3.4. If a shipping lot is made up out of more than one production lot each of bolts and/or nuts the specified testing frequency shall apply to each combination of bolt

and/or nut production lots in the shipping lot. For field verification testing frequency shall be as specified in Subsection 504.28(g).

Additionally, subsequent to the satisfactory performance of the above specified rotational capacity test(s) at the project site, for each shipping lot and for each position of the DTI relative to the turned element of the fastener assembly a DTI verification test shall be performed as follows:

- (1) Install bolt, nut, DTI, and hardened washer in a calibrated Skidmore-Wilhelm or equivalent tension measuring device with the DTI under the unturned element (either head or nut) using a flat insert instead of the normal bolt head restraints to allow access to the DTI. NOTE. The DTI shall not be used under the turned element, except with special permission of the Engineer.
- (2) Using two wrenches, one to restrain the unturned element of the fastener assembly and one to tighten the assembly, tighten the assembly to 1.05 times the required minimum bolt tension as shown in Table 1A - Bolt Tension, Section 504, Structural Steel.
- (3) After tightening the assembly as specified under (2) above, determine:
 - (a) The number of spaces in which a 0.4 mm [0.015] inch thick feeler gauge is refused.
 - (b) The number of spaces in which a 0.13 mm [0.005] inch thick feeler gauge is refused.

TABLE 4

		DTI Verification Criteria *									
M164M (A325M)		[M164 (A325)] Bolts									
Bolt Metric Sizes		16	20	22	24	27	30				36
Size English Size		1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	
Number of Spaces in Washer		4	5		6			7		8	
Number of Spaces Gauge is Refused		1	2		2			3		3	

*If a coated DTI is used under the turned element with permission of the Engineer the 0.13 mm [0.005 inch] thick feeler gauge shall be able to be inserted in at least one space.

- (4) The minimum number of spaces in which a 0.4 mm [0.015 inch] thick feeler gauge is refused and the maximum number of spaces in which a 0.13 mm [0.005 inch] thick feeler gauge is refused shall be as tabulated in Table 4 - DTI Verification Criteria. Failure to meet either of the above criteria will be cause for rejection.

- (5) Following successful completion of Step 2 above tighten the assembly till a 0.13 mm [0.005 inch] thick feeler gauge is refused on all spaces and a 0.8 mm [0.003 inch] thick feeler gauge can be inserted in at least one space. Note the tension in the bolt at this smallest gap.
- (6) After removal from the tension measuring device the fastener assembly shall meet one of the following criteria:
 - I. It shall be possible to turn the nut by hand for the full length of the thread, excluding the thread runout. Or, failing this, as an alternate.
 - II. The measured tension in the bolt during step (5) above shall be less than 95% of the maximum bolt tension recorded during step (d) of the rotational capacity test.
- (7) If the fastener assembly fails to meet both of the criteria under (6) the lot of DTI's represented by the tested DTI will be rejected.
- (8) For DTI's to be used with fastener assemblies too short to be tested in the tension measuring device the lot of DTI's shall be tested to steps (1) through (4) with a longer bolt. If acceptable according to (4) the DTI's shall then be tested by tightening a fastener assembly to the minimum gap as specified under (5) using a steel plate or plates of the required thickness. Following this the assembly shall meet the requirements of (6)I.

Submission of test reports for all tests required under the applicable AASHTO or ASTM Specifications, or specified herein is mandatory, test reports shall be notarized and shall contain, in addition to the test data, name and address of the testing agent, the manufacturer of the tested material and means of positively identifying the lot, batch or shipment tested, when such lot, batch or shipment arrives at the job site. Mill test reports shall be furnished for all steel used in the manufacture of the supplied bolts, nuts and washers and shall identify the place of origin.

Bolts, nuts and washers and DTI's shall be marked to comply with AASHTO M164M (ASTM A325M) [AASHTO M164 (ASTM A325)] Section 14 for bolts, AASHTO M291M (ASTM A563M) [AASHTO M291 (ASTM A563)] Section 10 or AASHTO M292/M292M (ASTM A194/A194M) Section 14 for nuts and AASHTO M293M (ASTM F436M) [AASHTO M293 (ASTM F436)] Section 14 for washers and ASTM F959M/F959 Section 17 for DTI's. Bolts, nuts or washers that lack either the grade mark and/or the manufacturer's mark specified above will be rejected.

713.03 Preformed Pads. Preformed pads shall be made with new unvulcanized rubber and unused fabric fibers and shall be approximately 3 mm [1/8 inch] thick after compression and vulcanizing with a proportion of fiber content sufficient to maintain strength and stability. The surface hardness shall be 85 to 95 Shore A Durometer. The ultimate breakdown limit of the pad under compressive loading shall be no less than 70 MPa [10,000 pounds per square inch].

713.04 Bronze or Copper-Alloy Bearing and Expansion Plates. Bronze bearing and expansion plates shall conform to the requirements of AASHTO M107 (ASTM B22), Alloy No. 911 and copper alloy bearing and expansion plates shall conform to the requirements of AASHTO M108, (ASTM B100) Alloy No. 510 or 511, unless otherwise specified. The bearing surface(s) subject to sliding action shall be provided with trepanned recesses (not grooves) filled with a lubricating compound. The lubricating compound shall consist of graphite and metallic substances with a lubricating binder capable of withstanding the atmospheric elements. The compound shall be pressed into the recesses so as to form dense, non-plastic lubricating inserts. The lubricating area shall comprise between 25 and 35 percent of the total area of the plate subject to sliding action. The sliding surface(s) shall be planed parallel to the prevailing direction of movement of the structure and subsequently polished, unless detailed otherwise.

713.05 Cold-finished Carbon Steel Shafting. Cold-finished carbon steel shafting shall conform to the requirements of AASHTO M169 (ASTM A108). Grade Designation 1021-1030 inclusive, cold drawn, either semi-killed or fully-killed shall be furnished unless otherwise specified.

713.06 Castings. Gray iron castings shall conform to the requirements of AASHTO M105. Class Number 30 shall be furnished unless otherwise specified.

Malleable iron castings shall conform to the requirements of ASTM A47M [ASTM A47]. Grade Number 22010 [Number 32510] shall be furnished unless otherwise specified.

Steel castings shall conform to Standard Specification for Steel Castings for Highway Bridges, AASHTO M192/M192M or mild-to-Medium Strength Carbon-Steel Castings for General Applications AASHTO M103/M103M (ASTM A27/A27M). The class 70 or grade 485-250 [70-36] of steel, respectively, shall be used unless otherwise specified.

Castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes and other defects in positions affecting their strength and value for the service intended.

Castings shall be boldly filleted at angles and the arrises shall be sharp and perfect.

All castings must be sand blasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean and uniform surface.

713.07 Metal Bin Type Retaining Wall. The metal for bin type retaining wall members shall be galvanized and shall conform to the applicable requirements of AASHTO M36/M36M.

When fiberglass, aramid or carbon graphite fiber coating is specified, the galvanized metal sheets used to form the retaining wall, except the base plates and connecting channels, shall additionally be coated on both sides with a layer of fiberglass, aramid or carbon graphite fibers applied in sheet form by pressing it into the molten spelter. Immediately after the metallic bond has solidified the fibers shall be thoroughly saturated with a bituminous saturant conforming to the following requirements:

Penetration at 25 °C, 100g., 5 sec.	35-45 tenths of a mm
Loss on heating at 163 °C, (325 °F) 50g., 5hrs	Not more than 1.5%
Flash point (open cup)	Not less than 226 °C [440 °F]
Penetration at 25 °C, 100g., 5 sec., of residue after heating at 163 °C, [325 °F] as compared with penetration of asphalt before heating	Not less than 70%
Insoluble in carbon disulfide	Not more than 2%

Testing shall be in accordance with methods specified in AASHTO M20.

Whenever possible in the manufacture of the units, a minimum forming radius of 25 mm [1 inch] is to be maintained. All units that are formed with less than 25 mm [1 inch] radius shall be hotdipped galvanized after forming.

Bolts shall conform to the requirements of ASTM F568 Class 4.6 [ASTM A307] and galvanized in accordance with ASTM A153.

713.08 Steel Extrusions. Material for steel extrusions for expansion devices shall be ASTM A36/A36M, A588/A588M or A242/A242M, except that ASTM A242/A242M shall not be used for extrusions that are to be welded.

713.09 Vacant

SECTION 714 -- JOINT SEALS

714.01 Elastomer for Seal Elements. The elastomer for seal elements, both compression and gland type, shall conform to the requirements of AASHTO M297 (ASTM D3542) except as follows. For gland type seal elements the low temperature and high temperature recovery tests may be omitted. The hardness shall be Durometer A, 60 ± 5 .

Ethylene Polypropylene Diene Monomer (EPDM) may be supplied as an alternate material for gland type seal elements. Its hardness shall be Durometer A, 80 ± 5 and the oven aging test, ASTM D573, shall be revised to allow 25 percent maximum loss of elongation. All other requirements shall be as above described for Neoprene.

714.02 Fabric for Seal Elements. Fabric used for reinforcement in a seal element shall be a non wicking fabric conforming to the requirement of ASTM D578.

714.03 Lubricant Adhesive. The lubricant-adhesive shall be a 1 part, moisture curing, polyurethane and aromatic hydrocarbon solvent mixture and shall have the following physical properties:

Solids content	60-80 percent by weight
Service Range	-15 °C [5 °F] to 49 °C [120 °F] minimum
Film Strength (ASTM D412)	8.3 MPa [1200 psi] minimum
Elongation at Break	250 percent minimum

Each lot of lubricant-adhesive shall be delivered in sealed containers plainly marked with the manufacturer's name or trademark and the date of manufacture.

714.04 Sealant. The sealant shall be a one part, moisture curing, polyurethane base elastomeric product, conforming to the requirements of Federal Specification TT-S-0023OC(2), Type II, Class A.

Each lot of sealant shall be delivered in sealed containers plainly marked with the manufacturer's name or trademark and the date of manufacture.

714.05 Compression Seals. Compression seals shall be multichannel extruded shapes conforming to the requirements of AASHTO M297 (ASTM D3542) except as hereinafter modified. At the time of manufacture, the seals shall be clearly marked on the top surface at $300 \text{ mm} \pm 2 \text{ mm}$ [$1 \text{ foot} \pm 1/16 \text{ inch}$] intervals and shall show the manufacturer's name or trademark, the lot number and the size designation at intervals of 1.5 m [5 feet] or less. Actual seal dimensions shall not differ from the nominal dimensions by more than 2 mm per 25 mm [$1/16 \text{ inch}$ per inch] of depth or width, or a maximum of 6 mm [$1/4 \text{ inch}$] whichever is less. For new construction, the nominal seal depth shall be not less than 100 percent of the nominal seal width, and shall be not less than 65 percent of the nominal seal width for bridge rehabilitation projects.

Each type and size of seal will be prequalified by the Maine Department of Transportation. Such prequalification shall be valid for use on any project until cancelled by the Maine Department of Transportation.

In order to be prequalified, a 600 mm [2 foot] length of seal shall be submitted to the Engineer. The Engineer will establish a movement rating based on the following criteria:

1. The maximum opening (L.C.* max) shall be 0.85 times the nominal seal width.
2. The maximum opening (L.C * min) shall be determined to be the point on the pressure - deflection curve for the tested seal, where the "Load Rate" (slope of the tangent to the pressure-deflection curve) reaches 13 kPa/mm [$6 \text{ psi/.125 inches}$], multiplied by the actual seal depth and sample length.

For each type and size of seal submitted for prequalification, a notarized statement from the manufacturer, attesting conformance with the provision of Subsection 714.01, shall be submitted, accompanied by notarized copies of the results of all required tests specified under Section 714.01 and as modified thereby.

*L.C. = Limit of Compression

714.06 Gland Type Seals. Gland type seals shall be single membrane extruded or molded shapes, made of material conforming to the requirements of Subsection 714.01 and of a configuration as determined by each manufacturer and as shown on the plans. The seals shall be marked on the top surface with the manufacturer's name or trademark, the lot number and the

size designation at intervals of 1.5 m [5 feet] or less. If fabric is used to reinforce the seal, it shall conform to the requirements of Subsection 714.02.

Each type and size of seal shall be prequalified by the Engineer, based on cross-sectional and material data submitted by the manufacturer. Such prequalification will be valid for use on any project until the manufacturer changes the material and/or cross-sectional characteristics of the seal from those on which the prequalification was based.

For each type and size of seal submitted for prequalification, a notarized statement from the manufacturer, attesting conformance with the provisions of Subsection 714.01 and 714.02 shall be submitted, accompanied by notarized copies of the results of all required tests, specified under Subsection 714.01 and 714.02 and as modified thereby.

714.07 Stud Bolts. Stud bolts shall be pitch diameter base, solid fluxed studs. Material for stud bolts shall conform to ASTM A108 (AASHTO M169), Grade 1020, either semi-killed or fully-killed. Nuts for stud bolts shall conform to ASTM F568 [ASTM A307, Grade B]. Thread fit shall be 6H/6g [UNC2A].

SECTION 715 -- LIGHTING MATERIAL

715.01 Vacant

715.02 Steel Conduit. Galvanized steel conduit shall be of uniform thickness with scale-free, smooth circular bore to permit cutting of clean, true threads.

Steel conduit and couplings shall be Schedule 40 galvanized steel pipe conforming to the requirements of ASTM A53. Threaded couplings shall be conduit type permitting the end of conduits to fully abut each other squarely within the coupling. Other fittings for metal conduit, exclusive of bushings shall be threaded malleable iron conforming to the requirements of ASTM A338 and shall be galvanized in accordance with the requirements of ASTM A153.

All bushings shall be threaded, insulated grounding type.

715.03 Non-Metallic Conduit. Non-metallic conduit shall be rigid unplasticized polyvinylchloride conduit, suitable for Type II or Type III installations, whichever is required and shall conform to the standards of the NEMA or the UL.

715.04 Prewired Conduit. The prewired conduit shall be a unit assembly consisting of the required insulated conductors and neutrals enclosed in a medium or high density polyethylene duct. The conduit shall be flexible enough for easy coiling or uncoiling at -10 °C [15 °F]. The duct shall be extruded directly over the paralleled conductors at the factory.

The percent of conduit fill shall be in accordance with the NEC and the UL.

- (a) Scope: Polyethylene plastic pipe in either medium density or high density grade, in sizes 19 mm [3/4 inch] through 63 mm [2½ inches] for direct earth burial.

(b) Materials:

1. Medium density polyethylene shall meet the applicable requirements as defined in ASTM D1248- 70a, Type II, Class C, Category 5 Grade P23.
2. High density polyethylene shall meet the applicable requirements as defined in ASTM D1248-70a, Type III, Class C, Category 5 Grade P34.
3. In addition, the above materials shall meet the requirements as shown below:

<u>Property</u>	<u>Medium Density</u>	<u>High Density</u>	<u>Test Method</u>
Tensile Strength, Minimum Mpa [psi]	17.2 [2500]	19.3	ASTM D638M
Elongation, Minimum Percent	400	400	ASTM D638
Melt Index, Maximum	0.4	0.4	ASTM D1238
Brittle Temperature			
80% Non-failure	-76 °C [-105 °F]	-76 °C [-105 °F]	ASTM D746
Environmental Stress Cracks Resistance, Maximum Failures Per 10 Specimens after 48 Hrs.	2	2	ASTM D1693

The duct shall have dimensions consistent with iron pipe size Schedule 40 conduit. The prewired conduit shall be shipped in continuous lengths on suitable reels.

The wires shall be stranded soft drawn coated copper conductors individually insulated with class THW insulation rated at 75 °C [165 °F], wet or dry. Insulation thickness shall be 600 volt rated. Phase identification shall be accomplished by numerical coding. Duct size and wire size shall be as indicated on the plans. The wire shall be UL approved.

Terminal connections, splices and test data requirements shall be as specified in Subsection 715.07.

715.05 Metallic Junction and Fuse Box. Surface-mounted junction boxes and fuse boxes shall be of either hotdipped galvanized cast iron or cast aluminum with hinged screw down covers.

Cast iron boxes shall conform to the requirements of Gray and Malleable Iron Castings, Subsection 713.06. Cast aluminum boxes shall conform to ASTM B108 or ASTM B26/B26M alloy 356.0.

All boxes shall be furnished with mounting lugs of adequate sizes and threaded bosses properly located and of sufficient thickness to provide a minimum of five full threads for all sizes of conduit used.

Fuse boxes shall be furnished with 5-ampere, cartridge type midget fuses, 10.3 mm [13/32 inch] in diameter and 38 mm [1½ inches] long with 600 volt fuse holder, unless indicated otherwise on the plans. Fuse boxes shall be bossed for fuse holder mounting.

715.06 Vacant

715.07 Secondary Wiring. Secondary wiring cables, including neutrals and grounding conductors, shall be 600 volt cables and shall consist of single conductor, stranded, soft-drawn or annealed copper wire, insulated with flame retardant, moisture and heat resistant thermoplastic material. The cable shall be UL approved and listed as THW.

Wire shall be of sufficient size to allow a maximum voltage drop of 5 percent from source of power to the most remote luminaire. Phase identification shall be made by factory-applied color coding.

Terminal lugs shall be cast copper alloy, solderless, mechanical type.

All conduit connections in above ground junction boxes and light standards shall be made by connector kits, fused or nonfused, as indicated on the plans. Splices for the roadway lighting shall be made by straight through or wye connector kits as required. Where these connector kits cannot be used as verified by the Engineer, connections on cables in junction boxes shall be made by splicing as described elsewhere. The connector kits shall be a quick disconnect type. Double connector kits shall be used where there is more than one phase conductor.

Fused "wye" connectors shall be composed of a "wye" line side housing assembled with a load side and fuse terminal housing. The housing shall be formed from water-resistant synthetic rubber. Each housing shall provide a water seal around the cables and when fully assembled shall form a watertight connector.

The interior shall be arranged to receive and retain line side wiring and the fuse contacts. The fuse contacts shall be spring-loaded copper designated for 30 amperes, 600 volts, shall have 90 percent minimum conductivity and shall be suitable for gripping a 5 amperes or as designated on the plans, 600 volt cartridge type midget fuse approximately 10.3 mm [13/32 inch] in diameter and 38 mm [1½ inches] long. The contacts shall be fully annealed. The load side conductors shall be connected by crimping and the line side conductors shall be connected with screws. The connector shall be of the nonlocking type that will break off under extreme tensile stress leaving no exposed metal contacts on the line side of the connector.

The cable diameter used will determine the size of each housing. The load side housing shall retain the fuse when disconnected.

Non-fused connectors shall be similar to the fused "wye" connectors. The cable diameter will determine the size of each housing of each connector.

Fuses for connectors shall be rated at 5 amperes or as indicated on the plans.

Underground splices shall be made with cast epoxy splice kits.

715.08 Luminaire, Lamp and Ballast. The luminaire shall be designed for the wattage rating and voltage indicated on the plans and for operating on a multiple circuit, using the type of lamps indicated on the plans. All luminaires shall be new and be the product of the same manufacturer.

The luminaire shall be constructed of an aluminum housing and refractor-holder, a refractor-holder latch on the street side and hinge with safety catch on the house side of the luminaire, and a detachable reflector with heat resisting gasketing between the reflector and the socket entry. Luminaires shall mount by a universal slipfitter, which shall clamp onto at least 150 mm [6 inches] of a 32 to 57 mm [1¼ to 2¼ inch] bracket.

The refractor shall be made of aluminum and finished with prismatic acrylic. For the cutoff optics, a flat glass lens shall be standard except for a dropped clear lexan polycarbonate resin globe for improving the cutoff performance.

Light distribution shall be as shown on the plans and shall conform to ANSI or IES type as specified.

The luminaire shall be supplied with a power factor ballast, of the lag-type regulator capable of operating from a multiple circuit as indicated on the plans. The ballast shall maintain lamp wattage to 6.8 percent regulation with 1 percent change in primary voltage variation. Ballast shall provide satisfactory lamp starting and operation to -29 °C [-20 °F]. The ballast shall be prewired to the lamp socket and terminal board, requiring only connection of the power-supply leads to the ballast primary terminals. The minimum efficiency of the ballast shall be not less than 60 percent; the power factor not less than 90 percent.

Lamps shall be of the type and wattage-rating indicated below. Lamps used shall conform to the lamp designations as listed in the latest edition of the IES Lighting Handbook.

ANSI & MFG. LAMP DESIG. WATTAGE BALLAST # LUMENS LAMP LIFE (HRS)

<u>ANSI</u>	<u>MFG.</u>				
	LU50				
S68MS-50	C50S68	50	S68	4000	24000
	LU70				
S62ME-70	C70S62	70	S62	6000	24000
	LU100				
S54SB-100	C100S54	100	S54	9500	24000
	LU150/55				
S55SC-150	C150S55	150	S55	16000	24000

	LU250S				
S50VA-250/S	C250S50/S	250	S50	30000	24000
	LU1000				
S52XB-1000	C1000S52	1000	S52	140000	24000

The Contractor shall submit shop drawings of the luminaires, lamps and ballast data.

Underpass or under check luminaires shall be constructed such that the refractor is hinged and can be opened for maintenance. The beam angles shall be field adjustable for, but not limited to, 60 degrees and 70 degrees settings. The ballast shall be integrally mounted, regulator or constant wattage type and designed to operate from a 3 wire 240/480 volt circuit or voltage indicated on the plans.

Pole top luminaires shall be of colonial or traditional design shall consist of cast aluminum and slipfitter for 75 mm [3 inches] outside the diameter of the pole top, and aluminum side posts which are gasketed to the translucent white acrylic lens panels and cast aluminum top housing. The canopy shall be hinged to the lower housing, held closed with two captive screws and gasketed to the lens. In addition, the internal reflector/ refractor assembly shall be gasketed. The ballast shall be prewired to the terminal socket. The luminaire shall be factory painted black.

715.09 Luminaire, Lamp and Ballast for High Mast Lighting. The luminaire and ballast shall be designed for the wattage rating and type of lamp shown on the plans.

The maximum weight of the luminaire shall be 48 kg [105 pounds] and its projected area shall not exceed 0.29 m² [3.1 square feet].

The luminaire shall be open ventilated design with an optical system consisting of an aluminum reflector. The reflector shall have a smooth, non-porous inner surface and shall be readily attached to the ballast assembly by means of a captive stainless steel nut and machine screw.

The reflector with its aluminum cover shall be firmly attached to a cast ring. This ring shall have keyhole slots in its upper surface such that the reflector/refractor assembly may be readily attached to or detached from the luminaire bracket entry and lamp support assembly without completely removing the support bolts.

The luminaire ballast shall be enclosed within a Number 356 alloy cast aluminum housing which integrally attaches to the luminaire bracket entry and lamp support assembly. It shall be readily removable without removing the luminaire from the bracket arm.

The luminaire shall be attached to the bracket arm by a bracket entry and lamp support assembly. The base for this assembly shall be cast aluminum. The assembly shall include a side entry slipfitter designed for 50 mm [2 inch] pipe with provision for ± 3 degrees adjustment for levelling the luminaire. The lamp shall be vertical burning and prevented from undue vibration and backing out by means of a stainless steel lamp clamp attached to the assembly but separate

from the socket. An enclosed terminal block shall be included such that all electrical connections shall be removed from exposure to weather. A stainless steel or aluminum rolled rain shield shall be attached to the outside of this assembly.

All cast aluminum parts of the luminaire shall conform to ASTM B26/B26M or ASTM B108, Alloy 356.0.

The luminaire shall provide ANSI-IES Type I, Type IV or Type V distributions.

715.10 Photo Electric Control. The control shall meet the following minimum requirements:

- (a) Unit Design. The photo electric unit shall consist of a light sensitive element connected directly to a control relay without intermediate amplifications. The unit shall be zenith sensing type.
- (b) Housing. The photo electric control shall be housed in a weatherproof housing.
- (c) Operating Levels. The operating levels shall be factory set to turn on at approximately 20 lx [2.0 footcandles] and off at approximately 65 lx [6.0 footcandles].
- (d) Supply Voltage. The control shall be capable of operation on a supply voltage of 105 to 285 volts.
- (e) Base. The base of the unit shall be provided with a 3-prong, EEI-NEMA standard twist lock plug mounting.
- (f) Directional Design. The control shall be oriented in a northerly direction according to the manufacturer's recommendation.
- (g) Surge Protection. The unit shall have a built-in surge protective device for protection from induced high voltage and follow through currents.

715.11 Service Equipment. The service pole or service rack and other entrance equipment shall be as detailed on the plans.

The control cabinet shall be fabricated from cast aluminum, sheet aluminum, galvanized steel or stainless steel. The following are required:

- (a) Hinged cover with weather protected hasp for padlocking. The lock will be provided by others.
- (b) Mounting brackets.
- (c) Suitable bossed and threaded holes in the case wall for conduit installation.

- (d) Independent single pole magnetic trip circuit breakers.
- (e) Manual control switch.
- (f) Lightning arresters in load and line side - rated 650 Volts RMS, indoor type.
- (g) Contactor - One double pole, single throw mercury solenoid contactor with contacts rated at the voltage and amperes shown on the plans. The coil shall be capable of operating at the voltage shown on the plans, 60 hertz. The contactor shall be normally open unless otherwise specified. The contacts shall be mercury.

Ground rods shall be copperclad steel or galvanized, 16 mm [5/8 inch] diameter, 2.4 m [8 feet] long, complete with ground clamp and square head bolt.

Dry-Type transformers shall be designed for indoor and outdoor installation.

The following are required:

- (h) 25 KVA rating, 120/240 volt primary, 240/480 volt secondary, single phase 3 wire system, if single phase service is supplied.
- (i) Frequency - 60 hertz.
- (j) Key-hole mounting slots and lifting groove.
- (k) Insulation system for 115°C rise at 40°C ambient.
- (l) Wiring compartment located on bottom front of unit. Access through a single cover.
- (m) Heat barrier to protect connecting cables.
- (n) Connecting leads to extend 150 mm [6 inches] from box and identified with metal tags.
- (o) Core and coils to be contained within a non-ventilated weather-proof enclosure.
- (p) Conduit knockouts to be located on bottom, back and sides of wiring compartment.
- (q) Maximum sound level to be 40 decibels.

Rack-mounted circuit breakers shall be enclosed in NEMA 3R enclosures with raintight hubs. The breakers shall be rated for 3 pole, 125 amperes, 600 volt, 4 wire service. Lugs for padlocking shall be supplied.

The service entrance rack shall be constructed as shown on the plan. Minor modifications will be permitted, if approved by the Engineer to accommodate variations in equipment dimensions. Lumber shall be as shown on the plan. Bolts and hardware shall be hotdipped galvanized steel.

715.12 Lowering System for High Mast Lighting. Each pole shall be furnished with a mechanical lowering system operated by cables and an electrically operated winch which will permit servicing of the luminaires and associated electrical and mechanical apparatus from the ground. Lowering systems shall permit lowering of the complete assembly, including luminaires, ballasts, fuses and other apparatus which may require periodic inspection or servicing, to a height of 1.5 m [5 feet] or less above the pole base plate.

At the top of the pole shaft there shall be mounted a detachable head assembly which remains fixed in position during the raising and lowering operation. The head assembly shall consist of 3 or more symmetrically located fixed support arms which will carry the weight of the lowering assembly. The fixed head assembly shall incorporate no moving parts except for the necessary pulleys, rollers or sheaves which guide the lowering cables and electrical cable during the lowering operation of the assembly. The fixed head assembly and luminaire lowering ring shall be galvanized steel. All required pulley rollers or sheaves and associated bearings, bushings and shafts shall be constructed of highly corrosion resistant materials not relying upon plating of the parent material for corrosion protection. All pulleys and rollers attached to the head assembly shall have permanently lubricated bearings or bushings.

All parts of the head assembly shall be protected with covers, screens, shields, as necessary, to prevent entrance of dirt, moisture, ice accumulation, nesting of insects or birds or other contaminants harmful to the operation of the lowering device.

All miscellaneous fittings, fasteners or hardware shall be fabricated from corrosion resistant materials not relying on plating for their corrosion protection.

A lightning rod of approved design shall be attached to the top of each pole and shall be firmly attached to the pole shaft or head assembly to provide good electric bonding to the pole shaft.

The entire luminaire lowering ring assembly shall be raised and lowered by three or more symmetrically placed stainless steel aircraft type cables located inside the pole shaft and extending through the head assembly support arms and attached to the lowering ring. Electrical cable supplying energy from the base of the pole to the luminaire ring shall be rough service mining type cable consisting of 3-600 volt conductors assembled with a messenger into a single cable. No electrical disconnect shall be permitted at the top of the pole. In addition, a stainless steel guide cable or equivalent shall be attached to the inside of the pole shaft to prevent the twisting of the lowering and electrical cables during the raise-lower operation. Each of the stainless steel lowering cables shall be capable of supporting the entire lowering assembly.

When the luminaire ring assembly is in the fully raised position, a mechanism for securing the luminaire ring to the head assembly shall be provided. Such mechanism shall provide support for the lowering ring and shall latch the ring to the head assembly thus permitting the removal of

all tension on the cables. All mechanisms shall be designed to provide the operator with a positive means of ascertaining when the raising operation is complete and the ring assembly is in the proper resting position.

The inner portion of the lowering ring shall be equipped with a protective bumper or roller system which will prevent damage to the pole shaft surface and preclude excessive swing during the lowering-raising operation.

Winches shall be operated by an appropriately geared 120 volt electric drive motor with adjustable torque limiter which can be easily hand-transported. One drive motor assembly shall be furnished which will operate all units. The drive motor shall be designed to be readily attached to the pole and/or winch unit and capable of being controlled remotely from at least 6 m [20 feet] from the pole. The drive motor unit shall be equipped with a 480 to 120 volt weatherproof step-down transformer either attached to the drive motor assembly or supplied in a separate enclosure. The transformer shall be of a size compatible with the drive motor and must be adequately grounded to prevent electric shock. A rubber covered heavy duty type "SO" rated 600 volt cable with connectors shall be provided to test the luminaires when they are in a fully lowered position.

An approved junction box shall be installed in the handhole of each pole which will accommodate the terminations of the underground cable with the cable in the pole serving the luminaires and to include a 480 volt grounded receptacle.

Secondary lightning arresters shall be rated for 650 volts RMS and shall be designed for outdoor use. The arresters shall be installed in each phase conductor to ground and shall be attached in or on the luminaire lowering device in a location accessible for inspection and servicing when the device is lowered.

715.13 Astronomical Time Switch. The time switch shall be installed in a welded steel case suitably protected with a zinc rich primer and epoxy tar finish, an aluminum weatherproof case or a stainless steel case. External fitting shall be corrosion resisting steel and provision shall be made for padlock mounting.

The time switch shall meet the following requirements:

- (a) Energize lighting system at sunset and de-energize at sunrise.
- (b) Be designed to operate on the designed circuit voltage.
- (c) Be operated by a synchronous motor with mainspring reserve with 10 hour carryover during power failure.
- (d) On-off switching scheduled to be controlled by an astronomic dial which will energize the magnetic contactor.

SECTION 716 -- STRUCTURAL ALUMINUM AND RELATED MATERIAL

716.01 Aluminum Railings.

- (a) Aluminum Extrusions. Traffic rails, hand rails, splice bars and pales brackets shall conform to the requirements of ASTM B221M [ASTM B221], Alloy 6061-T6 or 6351-T5. Post and post bases shall conform to the requirements of ASTM B221M [ASTM B221], Alloy 6061-T6. Pales shall conform to the requirements of ASTM B429 Alloy 6063-T5. Washers shall conform to the requirements of ASTM B209M [ASTM B209], Alloy Alclad 2024-T4.
- (b) Aluminum Rivets. Rivets shall conform to the requirements of ASTM B316M [ASTM B316], Alloy 6061-T6 (cold heading). Rivets shall have a button type manufactured head. Self-plugging, aluminum blind fasteners for pale panels shall meet the following requirements: 1) Sleeve-ASTM B211M [ASTM B211], Alloy 5056 (Stabilized), 2) Pin-ASTM B211M [ASTM B211], Alloy 2017 (Naturally Aged). The driven fastener shall meet the requirements for ultimate shear and tensile strength of Military Specification MIL-R-7885.
- (c) Miscellaneous Aluminum Parts. Rail caps shall be either sand cast or permanent-mold cast and shall conform to the requirements of ASTM B26/B26M or ASTM B108, Alloy A356-T6. All aluminum bars and plates shall conform to the requirements of ASTM B209M [B209], Alloy 6061-T6. Standard structural shapes conform to the requirements of ASTM Specification B308.
- (d) Steel Anchor Assembly. Steel spacers for post anchors shall conform to the requirements of ASTM A36/A36M. Nuts embedded in concrete shall conform to the requirements of ASTM F568 Class 4.6 [ASTM A307].

Anchor bolts, exposed nuts and washers shall conform to the requirements of ASTM F568 Class 8.8 [ASTM A449] and shall be hot dipped galvanized in accordance with ASTM A153.
- (e) Stainless Steel Parts. Cap screws, for fastening clamp bars and set screws for pale-panel brackets shall conform to the requirements of ASTM F593, Alloy Group 1, Condition CW.

SECTION 717 -- ROADSIDE IMPROVEMENT MATERIAL

717.01 Fertilizer. Fertilizer shall be commercial fertilizer having available elements in conformity with the standards of the Association of Official Agricultural Chemists. The fertilizer shall be furnished in unopened bags with the weight, contents and guarantee analysis shown thereon or on a securely attached tag.

- (a) Packed Weight Granular Fertilizer shall be a commercial grade fertilizer containing extended use nitrogen in the following formulation:

20.5% Ureaform (38.0% of which is nitrogen)
32.5% Muriate of Potash (60% of which is Potassium oxide)
42.0% Diammonium Phosphate
5.0% Urea

- (b) Inert Filler Granular Fertilizer shall be a commercial grade fertilizer containing the following percentages of available nutrients by weight:

Nitrogen 10 percent
Phosphoric Acid 10 percent
Potash 10 percent

- (c) Water soluble fertilizer shall be completely soluble in water and contain the following percentages of available nutrients by weight and shall contain a coloring agent.

Nitrogen 16 percent
Phosphoric Acid 32 percent
Potash 16 percent

- (d) Slow release fertilizer packets shall be slow release fertilizer contained in a polyethylene perforated bag with micropore holes. Each bag shall contain 0.1 kg [4 ounces] of minimum water soluble fertilizer to be effective for 8 years. Packets shall contain the following percentage of available elements by weight:

Nitrogen 16 percent
Phosphoric Acid 8 percent
Potash 16 percent

The Engineer may approve the use of other fertilizers providing they contain an equivalent amount of nutrients in an acceptable form.

717.02 Agricultural Ground Limestone. Agricultural ground limestone shall be have the following mechanical analysis: At least 50 percent shall pass the 150 m [Number 100 mesh] sieve, 90 percent shall pass the 850 m [Number 20 mesh] sieve and 100 percent shall pass the 2 mm [No. 10 mesh] sieve. The total carbonates shall not be less than 80 percent.

Agricultural ground limestone may be shipped in containers or in bulk. Packaged material shall be delivered in the manufacturer's standard containers. The containers shall be new and so constructed to assure safe arrival at the site. The net weight of the contents, shall not exceed 50 kg [100 pounds] per container. The manufacturer's name and a guarantee analysis and the net weight shall appear on each container. Bulk shipments shall be accompanied by certificates stating manufacturer's name, weight and guarantee analysis.

717.03 Seed. All seed shall be certified as to mixture, germination and purity. Each variety of seed shall have a percentage of germination of not less than 80, a percentage of purity of not less than 85 and shall have not more than one percent of weed content. All seed shall be from the same or previous year's crop unless recent tests by an approved testing agency demonstrate that older seed meets the above requirements.

- (a) Seed Mixtures. The seed mixtures shall consist of seeds proportioned percent by weight as follows:

Method Number 1

Park Mixture

Creeping Red Fesque	50%
Kentucky Bluegrass	30%
Annual Ryegrass	20%

Method Number 2

Roadside Mixture Number 2

Creeping Red Fesque	50%
Kentucky Bluegrass	15%
White Clover	5%
Red Top	2%
Birdsfoot Trefoil, Var. Empire	3%
Annual Ryegrass	25%

Method Number 3

Roadside Mixture Number 3

0.7 kg [1½ pounds] of Roadside Mixture Number 2

0.25 kg [½ pound] of Crown Vetch Seed, Var.

Penngift or Chemung with inoculant

- (b) Crown Vetch seed (Caronille varia) shall be hulled and recleaned Penngift, Chemung or other approved Crown Vetch seed of the previous year's crop. Inoculating bacteria for crown vetch shall be furnished. The Crown Vetch seed shall be treated with inoculating bacteria immediately prior to sowing the seed, in accordance with the directions of the supplier. Inoculant shall be kept refrigerated at all times until used. When a hydraulic method of seeding is used, 3 times the normal recommended rate of inoculant shall be used.
- (c) Birdsfoot trefoil seed shall consist of the Empire variety from the present or previous years crop. The seed shall have a minimum germination of 85 percent and purity of 98 percent. Inoculant shall be furnished and kept refrigerated at all times until used.
- (d) Reed Canary grass seed shall be from the current or previous year's crop. The grass seed shall have a percentage of germination not less than 80, a percentage

of purity of not less than 85, and shall have not more than one percent weed content.

- (e) Annual Rye Grass Seed shall be from the current or previous years crop. The grass seed shall have a percentage of germination not less than 80, a percentage of purity of not less than 85 and shall have not more than one percent weed content.

717.04 Mulch.

- (a) Hay or straw mulch shall consist of long fibered hay or straw, reasonably free from noxious weeds and other undesirable material. No material shall be used which is so wet, decayed or compacted as to inhibit even and uniform spreading. No chopped hay, grass clippings or other short fibered material shall be used unless directed.
- (b) Cellulose fiber mulch shall consist of elongated virgin wood fibers capable of producing a strong yellowbrown reaction with Graff C Stain for the presence of lightening in accordance with TAPPI test T 401 os-74. The ash content shall not exceed 2.0 percent.

The material shall be non-toxic to plants and animals upon contact and shall contain a green color sufficient to provide a definite contrast with the ground surface for metering purposes. It shall be supplied in uniform moisture resistant package not exceeding 50 kg [100 pounds] each and marked to show the air dried weight for tank mixing purposes.

- (c) Wood chips for mulch shall be obtained from green wood and shall average 3 mm [1/8 inch] in thickness with 50 percent having an area of not less than 650 mm² [1 square inch] nor more than 5000 mm² [8 square inches]. Not more than a total of 2 percent by volume shall consist of sawdust, shavings and leaves. The mulch shall contain no foreign material injurious to plant growth. Wood chips made from badly weathered or decayed material will not be accepted. Wood chips which have been stored long enough to become decayed will not be accepted unless approved by the Engineer.
- (d) Bark mulch shall consist of soft wood bark fragments of such size and texture as to successfully resist washing or blowing under normal conditions but capable of being easily and uniformly spread around the plants. No large peel strips and decayed material will be permitted.
- (e) Stone mulch shall be clean native stone, except limestone, consisting of stone particles passing a 19 mm [¾ inch] screen, but retained on a 6.3 mm [¼ inch] screen. This material shall be free from dust, dirt or other foreign matter.

Stone mulch will normally be used around individual trees or on plant beds that are in traffic islands or in other areas requiring frequent mowing. Wood Chip or bark mulch will normally be used on all other plant pits and beds.

- (f) Plastic membrane shall be an approved black plastic blanket of at least 0.15 mm [6 mil.] thickness.

717.05 Mulch Binder. Material for mulch binder may be emulsified asphalt of a type acceptable to the Engineer and may be diluted with water to assure even distribution. Other types of approved mulch binders may be used when authorized.

717.06 Vacant

717.061 Temporary Erosion Control Blankets.

- (a) Excelsior erosion control devices shall consist of a machine produced mat of curled wood excelsior of 80 percent 150 mm [6 inches] or longer fiber length. The fiber shall be of consistent thickness and evenly distributed over the entire area of the blanket. Both sides of each blanket shall be covered with either a 75 x 25 mm [3 by 1 inch] weave of twisted kraft paper having a high wet strength or a 50 x 25 mm [2 by 1 inch] biodegradable extruded plastic mesh. The blanket shall be made smolder resistant without the use of chemical additives.

METRIC UNITS

Width, in millimeters	Type I 900±25 mm Type II 1200±25 mm
Length, in millimeters	Type I 3800 average Type II 4570 Average
Weight per roll, kilograms	Type I 18±10 percent Type II 29±10 percent
Weight, Kilograms per square meter	Type I 0.39±10 percent
Fiber Dimensions, millimeters	0.53 x 1.07 ±25 percent

ENGLISH UNITS

Width, in inches	Type I 36±1 inch Type II 48±1 inch
Length, in inches	Type I 150 average Type II 180 average
Weight per roll, pounds	Type I 40±10 percent Type II 64±10 percent
Weight pounds per s.y.	0.8 lbs. ±10 percent
Fiber Dimensions	.021 x .042 ±25 percent

- (b) Straw-Coconut erosion control blankets shall consist of a machine produced mat of 70 percent wheat straw and 30 percent coconut fiber, photodegradable netting on both sides and is sewn together with cotton thread.

The blankets shall meet the following minimum requirements:

METRIC UNITS

Straw content - 2.6 kg/m²
Coconut Fiber content - 0.10 kg/m²
Light Wh. netting - one side only
Heavy Wh. netting - one side only
Thread - biodegradable cotton
Roll width - 1.98 m
Roll length - 25.45 m
Roll weight - 20.8 kg

ENGLISH UNITS

Straw content - 5.3 lb. per sq. yd.
Coconut Fiber content - 0.23 lb. per sq. yd.
Light Wh. netting - one side only
Heavy Wh. netting - one side only
Thread - biodegradable cotton
Roll width - 6.5 feet
Roll length - 83.5 feet
Roll weight - 46 pounds.

- (a) Coconut fiber erosion control blankets shall consist of a machine produced mat of 100 percent longlasting coconut fiber, non-photodegradable netting on both sides and is sewn together with nylon thread. The blankets shall meet the following minimum requirements:

METRIC UNITS

Coconut fiber content - 0.45 kg/m²
Heavy Wh. netting - both sides
Thread - 100 percent polyester
Roll width - 1.98 m
Roll length - 25.45 m
Roll weight - 29.3 kg

ENGLISH UNITS

Coconut fiber content - 0.92 lb. per sq. yd.
Heavy Wh. netting - both sides
Thread - 100 percent polyester

Roll width - 6.5 feet
Roll length - 83.5 feet
Roll weight - 60 pounds

- (d) Interwoven biodegradable paper strips knitted with synthetic yarns shall have a roll width of no less than 1.4 m [56 inches] and up to 2.87 m [113 inches], a roll length of no less than 175 m [575 feet] and a minimum roll weight of 18.6 kg [41 pounds].
- (e) Straw erosion control blankets shall consist of a 13 mm [$\frac{1}{2}$ inch] layer of chopped straw, knitted into a secure mat with a thin netting of biodegradable polypropylene. Roll widths will range from 1.2 m to 2 m [4 feet to 6½ feet].

717.062 Extended Use Erosion Control Blankets.

- (a) Jute erosion control blankets shall be of uniform plain weave single jute yarn averaging approximately 59 kg per spindle of 13 170 m [130 pounds per spindle of 14,400 yards]. The yarn shall be loosely twisted having an average twist of not less than 1.6 turns per 25 mm [1 inch] and shall not vary in thickness more than half its normal diameter. The blanket shall be woven 1.2 m [48 inches] in width, plus or minus 25 mm [1 inch], 78 warp ends per width of cloth; 44 weft ends per meter [41 weft ends per yard] and shall be furnished in lengths of not less than 30 m [100 feet]. The weight shall be approximately 0.60 kg per linear meter [1.22 pounds per yard] with a tolerance of plus or minus 6 percent. All materials shall be new and unused.

The Engineer may approve blankets with minor variations in material or weave provided that weight requirements per unit of area are met. He may also approve blankets of a different width.

- (b) 10 mm [0.4 inch] thick entangled mylar monofilament blankets shall be a flexible bulky mat of open construction. The monofilaments shall consist of mylar 6 with a minimum content of 0.5 percent by weight of Carbon Black. The blankets shall meet the following minimum requirements:

Weight - $265 \pm 7\%$ grams per square meter
Thickness - 10 mm [0.4 inch]
Roll width - 970 mm [38 inches]
Roll length - 150 m [492 feet]
Filament diameter - 0.35 mm
Length direction strength - 80 kg/m
Width direction strength - 40 kg/m
Elongation in length direction - 50 percent
Elongation in width direction - 50 percent
Resiliency - 80% 30 minimum recovery

- (c) 20 mm [0.8 inch] thick entangled mylar monofilament blankets shall conform to the requirements in (b) above, except for the following:

Weight - $405 \pm 7\%$ grams per square meter
Thickness - 20 millimeter [0.8 inch]
Roll length - 100 meter [330 ft.]
Filament diameter 0.40 millimeter.
Length direction strength - 140 kilograms per meter
Width direction strength - 80 kilograms per meter

- (d) 6 mm [one-quarter of an inch] thick entangled vinyl monofilament blankets shall be a flexible mat of open construction. The monofilament blankets shall consist of polyvinylchloride. The blankets shall meet the following minimum requirements:

Weight - 0.82 kg/m² [24 oz./sq. yard]
Thickness - 6 mm [0.25 inches]
Roll width - 1140 mm [3.75 feet]
Roll length - 54.9 m [180.0 feet]
Length direction strength - 8.2 kg [18 pounds]
Width direction strength - 2.7 kg [6 pounds]
Elongation in length direction - 150 percent
Elongation in width direction - 100 percent

- (e) Fine size mylar monofilament blankets heavily netted on both sides and shall meet the following minimum requirements:

Nylon fiber - 100%, 0.49 kg/m² [0.9 lbs.
per sq. yard]
Netting - heavy weight on both sides of blanket
Thread - 100 percent polyester and sewn to netting
Roll width - 1.98 m [6.5 feet]
Roll length - 25.4 m [83.5 feet]
Roll weight - 24.5 kg [54 pounds]

717.063 Ground Anchors. Ground anchors for temporary erosion control blankets shall consist of heavy duty steel or plastic staples and pins with a minimum length of 200 mm [8 inches]. Wooden staples capable of penetrating into the ground a minimum of 200 mm [8 inches] are approved blanket anchors.

Ground anchors for extended use erosion control blankets shall consist of heavy duty steel or plastic staples and pins with a minimum length of 250 mm [10 inches]. Wooden staples capable of penetrating into the ground a minimum of 250 mm [10 inches] are approved blanket anchors.

717.07 Herbicide. The herbicide shall be an approved chemical registered in this state for stump or basal bark treatment.

717.08 Manure. Manure shall be well-rotted manure approved by the Engineer and free of weeds, grass or harmful chemicals. Dehydrated cow manure may be used if approved by the Engineer.

717.09 Peat Humus. Peat Humus shall be a natural peat approved by the Engineer consisting of sedge, sphagnum or reed peat of such physical condition as will pass through a 25 mm [1 inch] screen and will be readily incorporated with the topsoil. The peat humus shall be free from sticks, stones, roots and other objectionable matter.

The peat humus shall come from a freshwater saturated area and be conditioned in stockpiles for at least 6 months after excavation, including one freezing and thawing period.

717.10 Vacant

717.11 Plant Supporting Material. Posts for supporting plants shall be straight sound cedar posts free of bark or an approved equal. They shall have a minimum diameter of 44 mm [1¾ inches] and a maximum diameter of 75 mm [3 inches]. Posts will be provided in 2 sizes, 1.8 m [6 feet] tall and 2.4 m [8 feet] tall. Where shorter posts are necessary to protect trees from injury, the 1.8 m [6 foot] size shall be used and cut to the required height.

Support ties shall be approved plastic chain-lock material, 11 mm [7/16 inch] minimum size.

Anchor stakes for guying trees shall be of sound hard pine or approved equal, 50 or 75 mm [2 or 3 inches] in diameter and 600 to 760 mm [2 to 2.5 feet] long, notched near the top to hold wire.

Guy wire shall be pliable, 10 to 20 gage galvanized steel wire or approved equal. Woven wire of approximately equal strength may be used if approved by the Engineer.

Hose for protecting the bark from guy wires shall be good quality reinforced rubber hose of 13 mm [½ inch] inside diameter or approved equal, in sound condition. Old, cracked material and light weight plastic is not permitted.

717.12 Wrapping Material. Wrapping material for tree trunks shall be furnished in strips approximately 100 to 150 mm [4 to 6 inches] wide consisting of first quality, 0.27 kg/ m² [8 ounce per square yard] burlap, approved waterproof paper or plastic.

Twine for tying wrapping material to trees shall be approved good quality jute twine, not less than 3 ply or approved heavy duty weather resistant tape.

SECTION 718 -- TRAFFIC SIGNALS MATERIAL

718.01 Vehicular Signal Indications.

- (a) Vehicular signal heads for traffic signals and flashing beacons shall conform to or exceed the current edition of the ITE "Standard for Adjustable Face Vehicle Traffic Control Signal Heads". Each housing section shall be complete with a one-piece, hinged door mounting for the lens and other parts of the optical system, watertight gaskets and simple door-locking device. The optical system shall be mounted so that the various parts may be swung open for ready access or removal. The sections shall be interchangeable and constructed so that sections can be removed or added.

There shall be a round opening in the top and bottom of each head to receive 38 mm [1½ inch] supporting pipe frame. All parts of the housing, including the doors and end plates shall be of die cast aluminum free from flaws, cracks, blow holes or other imperfections or polycarbonate.

All exposed bolts, screws, hinge pins and door-locking devices shall be stainless steel. All interior screws and fittings shall be stainless steel or approved nonferrous, corrosion-resistant material.

All gaskets, including door, optical assembly, exclusive of lampholder gaskets, shall be of neoprene. Lampholder gaskets shall be of a material unaffected by heat.

All light emitting diode optical assemblies shall be wired so that a white wire will be connected to the ground and black or colored wire to the terminal of the LED optical assembly. The wires shall in turn be connected to the terminal block mounted inside at the back of the housing. The terminal block shall have sufficient screw type terminals to terminate all field wires and lamp wires with separate screws. The terminals to which field wires are attached shall be permanently identified or the wiring shall be color coded to facilitate field work. Each LED assembly shall be provided with a removable visor hood unless tunnel hoods or louvered hoods are specified on the plans. Hoods for 200 mm [8 inch] sections shall be 175 mm [7 inches] long, hoods for 300 mm [12 inch] sections shall be 240 mm [9½ inches] long.

All heads to be modified shall be retrofitted with light emitting diode optical assemblies for all colors.

When 2 or more vehicular signal heads or a combination of vehicular signal heads and pedestrian signal heads are installed on 1 pole, only 1 conduit riser shall be used. The signal heads shall not be connected together by the use of liquid tight flexible metal conduit and terminal fittings.

All new vehicular signal faces installed at any one intersection shall be of the same make and type.

LED optical assemblies for the 200 mm [8 inch] units shall be 650-lumen minimum initial output, 120 volt, 100,000 hour rated life, clear traffic signal lamps. Lamps for the 300 mm [12 inch] units shall be 1900-lumen minimum initial output, 120 volt, 100,000 hour rated life.

The intensity and distribution of light from each illuminated signal LED optical assembly shall conform to the latest revisions of the ITE "Standard for Adjustable Face Vehicle Traffic Control Signal Heads", and the "Standard for Traffic Signal LED".

- (b) Programmed Visibility Vehicular Indications. The programmed visibility traffic signal vehicular indication shall optically determine the visibility zone of indication without the use of hoods or louvers. The projected signal may be visible or selectively veiled anywhere within 15 degrees of the optical axis.

The signal head shall be adjustable to various angles between 9 degrees above and below horizontal. No indication shall result from external illumination and each indication shall be illuminated separately. The visibility of the signal indication shall be adjustable within the signal head to fit the lane or lanes in which traffic is to be controlled.

The illumination lamp shall be a nominal 150 watt, 115 volt AC, 3 prong, sealed beamed type, having an integral reflector and an average rated life of 6,000 hours. A dimming device shall be provided to reduce the candela at each signal head for nighttime operation to approximately 15 percent of the candlepower for daytime operation.

A circular reflector with a specular inner surface shall mate the lamp to a diffusing element.

An internal imaging surface shall be provided to permit an effective veiling system to be applied as determined by the desired visibility zone. The Contractor shall notify the Engineer 48 hours prior to the application of the veiling system. The optical limited-diffuser shall be provided with positive indexing means and shall be composed of heat resistant glass.

The objective lens shall be a high resolution planar incremental lens thermetically sealed within a flat laminate of weather resistant acrylic. The lens outline shall be symmetrical. Lens colors shall conform to the latest ITE transmittance and chromaticity standards.

The signal shall be housed in cast aluminum, conforming to the latest ITE alloy and tensile requirements. Each section shall have a sun visor. The cast aluminum shall have a chromate preparatory treatment prior to the application of green or yellow baked enamel prime and finish. The lens cover and the interior of the case shall be flat black. Hinge and latch pins shall be stainless steel. All access openings shall be sealed with weather resistant rubber gaskets.

The lamp fixture housing shall be readily accessible and lamp replacement shall not require special tools nor necessitate major disassembly.

Electrical connections between the case and lampholder shall be an interlock assembly which disconnects the lampholder when open. Number 16 wire shall be used to connect the lamp receptacle to the signal head terminal.

The signal head shall be capable of being mounted to standard 38 mm [1½ inch] fittings as a signal head section, as a multiple section face or in combination with other signal heads.

The signal section shall be provided with a rigid connection that permits tilting from at least 9 degrees above or below the horizontal while maintaining a common vertical line through couplers and conduit. No special tools should be needed for servicing or mounting.

718.02 Pedestrian Signal Indications. The pedestrian traffic control signal heads shall conform to the ITE, "Standard for Adjustable Face Pedestrian Signal Heads", latest Edition. The housing shall be dust and moisture proof and corrosion resistant and shall provide easy access to all components. All pedestrian signal heads shall have a sun visor.

All pedestrian traffic control signal heads of the incandescent type shall be as outlined in the above Standard. All new pedestrian signal faces installed at any one intersection shall be of the same make and type.

The "Don't Walk" and "Walk" indications shall be separate heads and the "Don't Walk" indication shall appear directly over the "Walk" indication. The "Walk" message shall be lunar white and the "Don't Walk" message shall be Portland orange.

Head sizes shall be standard nominal 250 mm [9 inches] in minimum dimension unless otherwise specified.

LED optical assemblies for 225 mm [9 inch] units shall be 650-lumen minimum initial output, 120-volt, 100,000 hour rated life.

LED optical assemblies for 300 mm [12 inch] units shall be 1,900-lumen minimum initial output, 120-volt, 100,000 hour rated life.

When 2 or more pedestrian signal heads are installed on 1 wood pole, only 1 conduit riser shall be used. The pedestrian signal heads shall not be connected by the use of liquid tight flexible metal conduit.

Pedestrian signal heads which use fiber optic bundles to form the message shall achieve the color of the messages by filters between the light source and the optical bundles. The legends shall be 125 mm [5 inch] minimum in height with a 16 mm [5/8 inch] stroke. The housing materials shall conform to the requirements for conventional pedestrian signal housings. The

message shall be illuminated by a light source designed to operate on a 120-volt source and shall be rated for 100,000 hour average life. The flashing message shall be accomplished by use of a solid state flasher required for conventional pedestrian signal indications.

718.03 Signal Mounting. All trunnions, brackets and suspensions used for assembling and mounting signal control faces shall be entirely weather tight. The inside area of the cross section of the tubular arms shall not be less than the inside area of 38 mm [1½ inch] IPS pipe to permit the signal control wires or cable to be inserted through them.

All vehicular and pedestrian signal heads, regardless of mounting arrangement, after final adjustment shall be fastened by a positive locking device acceptable to the Engineer. This device shall prevent any deviation from the position set, but shall allow for readjustment of the signal head at a later date in the same installation or in another installation without the necessity of damaging any part of the signal head.

718.04 Loop Vehicular Detectors. Vehicle detectors shall consist of wire loops and self-contained detection equipment capable of registering independently the presence or passage of any vehicle passing over the loop at any speed up to 110 km/hr [70 miles per hour] and at any temperature between -37 °C and +74 °C [-35 °F and 165 °F]. Each loop detector shall contain its own integral power supply and shall operate between 95 VAC and 135 VAC. The input power shall be protected by fuse or resettable circuit breaker.

The detector amplifiers shall be self-tuning, solid state construction except for the output relay. Printed circuit design shall allow the components to be removed and replaced without permanent damage to the printed circuit boards or tracks.

Detector amplifiers installed in a common cabinet shall have a frequency difference and shall not interfere with the operation of other detector amplifiers installed in the same cabinet.

All input and output circuits for each amplifier shall enter by a single connector provided with a threaded shell. All controls, indicator lights, meters, fuseholders, circuit breakers and connectors shall be mounted on the front panel of the detector amplifier. All controls shall be adjustable without the use of tools and the controls shall be clearly and permanently identified.

The detector unit shall show a visible indication of vehicle calls. After a power interruption, the units shall return to normal operation within 30 seconds. If any vehicle stops over a portion of the loop registering a call, the detector shall be capable of detecting additional vehicles traversing the loop after approximately 15 seconds.

Detectors shall detect vehicles by lanes of traffic and shall not detect traffic moving away from the intersection when properly positioned in normal travel lanes. Detection must be positive and not erratic under all actual operating conditions with the exception of storm damage to the detector.

All detectors shall be capable of detecting all four-wheeled vehicles for all lengths of lead-in up to 230 m [750 feet] for single detection loops and for a combined lead-in length of 230 m [750 feet] in the case of multiple loops.

Detector loop wire shall be number 14 THWN stranded wire, moisture and heat resistant. Lead-in cable shall conform to the detector manufacturer's recommendations. The wire shall be encapsulated in vinyl tubing over its entire length.

No damage shall occur in the detector if the pavement loop or lead-in becomes short-circuited.

718.05 Microwave Detectors. Microwave detectors shall work on an operational frequency of 10.525 GHZ. The detection method shall be microwave with adjustable patterns with a response time of 165 milliseconds and an adjustable hold time of 0.5 to 5 seconds. It shall be powered from 10 VAC to 24 VAC. All contacts shall be form C, 5 amp rated. The detector shall have a fail safe microprocessor circuit so that if the unit fails it will place the controller in recall on the apparent phase.

718.06 Pedestrian Detectors. Pedestrian push button detectors shall be weatherproof and constructed to eliminate the possibility of electrical shock in all weather conditions.

The pedestrian push button switch shall be a phenolic enclosed precision snap-acting type, switching unit, single-pole, double-throw, with screw type terminals, rated 15 amperes at 125 volts, AC and shall have the following characteristics:

- (a) The switching unit shall have a stainless steel plunger actuator and shall be provided with U-frame to permit recessed mounting in push button housing.
- (b) Where a pedestrian push button is attached to a pole, the housing shall be shaped to fit the curvature of the pole and secured to provide a rigid installation. When required, saddles shall be provided to make a neat fit.

718.07 Controllers. All controllers shall be solid state menu driven keyboard units meeting NEMA standards and capable of operating in fixed time, semi-actuated and actuated modes or as designated on the plans. Controller shall have a programably "EE prom" chip with an internal real-time clock/calendar capable of daily, weekly, and yearly events time programming. The controller shall be designed to provide the number of intervals shown on the plans without any auxiliary equipment. Solid state controllers shall be provided with conflict monitors as specified in Section 718.11.

All equipment inputs, outputs and terminals shall be identified by the phase designations shown on the plans.

The reliability of the equipment shall be demonstrated by test performance which will confirm that the controller unit, fully wired cabinet and auxiliary equipment meet the operational and functional requirements of the plans and specifications.

The Contractor shall be responsible for providing all information describing the operation of the equipment necessary to facilitate the completion of the tests. All schematic wiring diagrams of the controllers and auxiliary equipment, all cabinet diagrams and all operation

manuals shall be submitted to the Engineer at the time the controllers are delivered for testing. These diagrams shall show in detail all circuits and parts. Such parts shown thereon shall be identified by name or number and in such a manner as to be readily interpreted.

The controller shall be delivered with all documentation manuals as per Subsection 643.17 to the Maine Facility, US Route 2, Palmyra, Maine, mailing address RFD Box 421, Pittsfield, Maine, 04967, with all internal connections made and ready for testing. The test will be performed under simulated field loads or manufacturer's design loads, whichever are greater. Testing will be performed by the Department.

The Contractor shall allow 21 days for the testing of each controller, commencing on the day the controller is delivered to the test site, exclusive of the number of days necessary for the Contractor to respond to defect notices and the number of days the Contractor requires to correct the defective equipment.

The test shall consist of not less than five days of continuous, satisfactory operation. If unsatisfactory performance of the controller develops during the test, the Contractor shall remove the defective equipment for repair within five working days after notification, correct the deficiency and the controller shall be retested, until the 5 days of continuous satisfactory operation are obtained. If repeated failures occur, the entire controller may be rejected, requiring the Contractor to submit a new controller for testing. Delays to the contract resulting from unsatisfactory test performance due to continued equipment failure will not be considered as a valid reason to justify extension of the contract time.

The Contractor will be notified when testing of the traffic signal equipment has been completed. It shall be his responsibility to transport the equipment to the work site.

Each traffic controller unit, flasher and all other current interrupting devices shall be equipped with a suitable radio interference suppressor installed at the input power point. Interference suppressors shall be designed to minimize interference in both broadcast and aircraft frequencies. Suppressors shall be designed for 125 percent of the total connected load and shall meet standards of the UL and the EIA.

The type of controller, auxiliary equipment and other operational features shall be as noted on the plans.

All equipment, except pedestrian push buttons, shall be designed to operate on 120 volt, 60 hertz. Operation shall be satisfactory at voltages from 105 to 130. The voltage for pedestrian push buttons shall not exceed 18 volts.

- (a) Auxiliary Functions. All controllers shall be capable of providing flashing operation of the signal lights, as indicated on the plans. Transfer from flashing operation or to flashing operation shall conform to the MUTCD. The clock for auxiliary functions shall be a solid state time clock or module.

If noted on the plans, preempt circuits shall be provided for emergency vehicles and/or railroad crossings. The clearance and preempt indications shall be as noted

on the plans. Preempt circuits shall function during stop and go and flashing operation unless otherwise noted. The duration of clearance and preempt intervals shall be adjustable over the range noted on the plans and shall be labeled according to function. The railroad preempt circuit shall be designed to operate as a fail-safe loop through a normally made contact on the railroad's control relay in the railroad's control cabinet. Railroad preemption shall have precedence over all preemption intervals for other purposes.

Actuated vehicle phases and actuated pedestrian phases shall be served in that interval of the cycle indicated on the plans. Time for an actuated interval shall be taken from the non-actuated phase(s) as noted on the plans.

Automatic transfer to or from flashing operation shall conform to the MUTCD. Manual advance of the intervals by use of hand cord control shall cause the controller to advance to the next programmed interval only upon pulse signal from the hand cord circuit, interval timing shall hold the interval for the minimum programmed amber and red clearance intervals.

- (b) Solid State Controllers. The controller unit shall be enclosed in a sheet metal case with protective painted finish, designed to permit easy access to the interior and removal of printed circuit boards and modules without the use of special tools. All program controls, fuses and indicator lights shall be mounted on the front panel and shall be clearly and permanently labeled. Modules of unlike function shall be mechanically keyed or electrically interlocked to prevent placement in the wrong location. Each module shall be identified with the symbol shown on the plans with an embossed, color contrasting, plastic label. All components shall be marked for identification compatible with the maintenance manual for the controller unit, including components mounted on printed circuit boards.

When on manual operation, all phases shall be called regardless of vehicle detection and the controller shall be advanced upon pulse from the hand cord circuit, except yellow and red clearance intervals shall be timed for the duration programmed.

An exclusive pedestrian phase shall not extend or recycle until a vehicle phase has been serviced. When on manual operation, all phases shall be called regardless of vehicle detection and the controller shall be advanced upon pulse from the hand cord circuit except yellow and red clearance intervals shall be timed for the duration programmed. Automatic transfer from or to flashing operation shall conform to the MUTCD.

Pedestrian phases shall not be extended by actuations, during the walk or clearance interval. Actuations during the clearance intervals shall be placed in memory.

718.08 Controller Cabinet. The traffic signal control equipment shall be enclosed within a dust and moistureproof aluminum or stainless steel housing with an auxiliary door in door

feature. The door hinge pins shall be made of stainless steel. The cabinet shall be installed with the back toward the nearest line of traffic unless otherwise directed by the Engineer.

The controller cabinet shall be of sufficient size to accommodate all control equipment including temperature control equipment. It shall be designed to be attached to the type of pole indicated in the contract plans. If attached to a traffic signal post, it shall be integral with the post giving the appearance of the signal post passing directly through the cabinet. If the controller cabinet is to be ground mounted, details of the installation will be shown on the plans. Piano type hinges on controller cabinet doors shall be fabricated of stainless steel with a stainless steel hinge pin.

All manual control switches, push button control, flashing switch, signal switch and any other specified switches shall be located so as to be accessible within the outside door, without exposing the controller mechanism.

The flashing mechanism for flashing beacon installations must be enclosed within a dust and moisture proof aluminum cabinet with a hinged door.

The flasher cabinet shall be of sufficient size to accommodate a 2 circuit solid state flashing mechanism and other necessary equipment. It shall be designed to attach to the type of pole indicated in the contract plans. The flasher cabinet shall be vented to prevent excessive heat build-up.

The locks for the door of the flasher cabinet shall be the type shown on the plans. Two keys shall be furnished with each control lock.

All cabinets housing solid state traffic signal control equipment shall be provided with a thermostatically controlled ventilating fan and throwaway glass fiber air filters. The electric fan shall have ball or roller bearings and shall have a capacity of 2.8 m³ [100 cubic feet] per minute. The ventilating system shall be designed to prevent the entrance of rain, snow, dust and insects. The fan and vents shall be arranged in such a manner that the air intake is at the cabinet bottom and the exhaust is at the cabinet top. The filter shall be firmly held in place such that cracks and openings are eliminated to ensure that all air is filtered. The fan shall be thermostatically controlled with an adjustable upper limit of 38 °C to 60 °C [100 °F to 140 °F] and a differential of not more than 5 °C [10 °F].

The locks for the switch compartment door of the controller cabinet shall be the type shown on the plans. The main door shall be a lock of the tumbler type. Two keys shall be furnished with each control lock.

All traffic signal controller cabinets shall be supplied with a convenience outlet, a standard 3-wire grounding duplex receptacle, 20 amp capacity and a lamp socket and 1900 lumen lamp.

A police panel shall be provided behind the auxiliary door and shall contain a switch to select "flash-automatic" function, "automatic-manual" function, "signals on-off" function and a manual control cord. Switch terminals on the rear of the main cabinet door shall be insulated so that no live posts are exposed. The "signal on-off" switch shall allow the signal indications to be

deenergized, but power to all other control circuits shall not be disrupted. Switches shall be labeled and rated for load current. Traffic signal controller cabinet main doors over 0.55 m² [6 square feet] in area shall be provided with a stop to limit door opening to both 90 and 180 degrees, ± 10 degrees. The stop shall be provided with a catch which can be operated when the door reaches these 2 positions and will hold the door open securely until released. Controller cabinets designated on the plans to be ground mounted shall have a pliable seal composed of caulking compound or mastic placed between the cabinet base and the concrete foundation to prevent dust and dirt from entering the cabinet. The bottom of the controller cabinet shall be mounted on an aluminum non breakaway transformer base as shown on the plans.

The cabinet shall be supplied with sufficient shelf space for all control units. Receptacles for relays, shelf spaces below all removable control equipment, contactors, switches, fuses, circuit breakers and terminal blocks shall be identified with plastic labels embossed with the symbol used on the plans to indicate the related function.

718.09 Flasher. The flasher shall be a two circuit solidstate device with no contact points or moving parts, producing between 50 and 60 flashes per minute with a 50 to 67 percent duty cycle. The flasher mechanism shall be mounted on a plug-in base with a plug-in mounting. The flasher relay shall energize the flasher and transfer signal light circuits from the controller unit to the flasher. The flasher shall be capable of breaking and carrying 10 amps on each circuit at 125 volts. All amber indications shall be on one circuit and all red indications shall be on the other circuit. The flasher shall be protected from lightning damage by a device intended for use with solid state equipment. The flashing mechanism shall be independent of the controller unit and shall remain in operation upon shutdown of the controller or removal of the controller unit from the cabinet. The pedestrian indications shall be flashed with a separate solid-state flasher.

718.10 Program Selection. The weekly program selection unit shall be capable of automatically supervising the operation of cycle 1, cycle 2, cycle 3, split 1, split 2, split 3, reset 1, reset 2, reset 3 and flashing operation. The weekly program selection unit shall allow selection and/or omission of these functions to be varied on a daily basis. The weekly program selection unit shall enable function transfers to be made as often as 15 minutes.

Solid state devices used to automatically select dial, reset and flashing modes shall meet the applicable functional requirements of mechanical devices. They shall maintain the preset program during power interruption and shall continue timing functions using a reserve power source.

718.11 Contacts and Relays. All contacts used in connection with interval indications shall be of pure coin silver or its equivalent and shall be capable of breaking and carrying at least 15 amperes at 120 volts AC. The Contractor is directed to arrange the internal wiring and number of circuits so that the contact rating is not exceeded.

All actuated controllers shall be equipped with external type signal light relays.

Relays shall not be used in connection with any automatic non-flashing red, yellow or green indication in installations having pre-timed electro-mechanical equipment, without the approval of the Engineer.

Relays shall be designed for continuous duty. Relays shall be designed to operate at ambient temperatures from -35 °C to +70 °C [-30 °F to +160 °F].

Each relay shall be mounted on a plug-in base with a plug-in mounting. Coils shall have a power consumption of 10 volt-amperes maximum and shall be designed for continuous duty on 120 volts, AC.

A leakage resistor, which shall permit current to pass through the relay coil if the contacts should remain closed after the coil circuit is opened, shall be installed with each external signal light relay to overcome residual magnetism effects.

All relays shall be of a rating sufficient to carry the electrical loads imposed upon them. A sufficient number shall be provided so that the total load is distributed among the various circuits in such a manner that the rating of each relay is 150 percent of the load.

The monitor unit shall be connected to the field terminals of the signal light circuit to provide protection against conflicting green, yellow or walk indications being simultaneously energized as a result of controller failure, relay or solid state switch failure, short circuited field wiring or other failures.

When a conflict is detected, the monitor unit shall cause the signal system to commence flashing operation; energize the stop-timing circuit of the controller while controller power shall remain on; lock-in flashing operation until manual actuation of the momentary contact reset push button; remove power from the signal light circuit; disable all functions of the "Flash-Automatic" and "Automatic Manual" switches in the police panel.

Each circuit of the solid state switching devices shall have a minimum rating of 1,000 watts for tungsten lamp load at 120 volts, AC. The solid state switching devices shall be plug-in mounted to a base. Solid state switching devices shall be protected from transient voltages and lightning by components especially designed for use with solid state devices.

Circuit breakers shall be approved and listed by the UL. The operating mechanism shall be enclosed and shall be trip-free from operating handle under load and shall be trip-indicating. All circuit breakers shall be quick-make, quick-break on either automatic or manual operation. Contacts shall be silver alloy enclosed in an arc quenching chamber. Overload tripping of breakers shall not be influenced by an ambient temperature range of from -18 °C to +70 °C [0 to +160 °F].

718.12 Conductors. The number and size of conductors required in each cable is indicated on the plans. All conductors shall be stranded copper conductors. Multiconductor cables shall conform to the latest revisions of IMSA Specification Number 19-1 or 20-1. The service ground rod shall be 2400 mm by 16 mm [8 feet by 5/8 inch] copperclad rod.

The service wiring shall be single conductor number 6 AWG THW stranded copper black insulated and number 6 AWG THW stranded copper white insulated rated 600 volts.

All circuits for the timer and each auxiliary control unit shall terminate in a multiple contact connector. Conductors shall be attached to all pins of the connector and cabled. Conductors of the cable, except spares, shall be fitted with terminal ends compatible with the terminal block and shall have identifying bands. The ends of all spare conductors shall be taped.

SECTION 719 -- SIGNING MATERIAL

719.01 Reflective Sheeting. The reflective sheeting shall consist of a retroreflective lens system having smooth outer surface. The sheeting shall have a precoated adhesive on the backside protected by an easily removable liner.

The reflective sheeting and its components shall conform with all the requirements of FHWA "Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects", FP-92, Section 718.01. Engineering grade reflective sheeting shall meet the reflective intensity requirements for Type II sheeting as shown in Table 718-1 Section 718.01, FP-92. High intensity reflective sheeting shall meet the reflective requirements for Type III sheeting as shown in Table 718-3 Section 718.01, FP-92.

719.02 Demountable High Intensity Reflectorized Letters, Numerals, Symbols and Borders. Demountable reflectorized letters, numerals, symbols and borders shall consist of cut out high intensity sheeting, conforming to FHWA, "Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects", 1992, FP-92, Section 718.01(d).

719.03 Aluminum Extrusions. The extruded aluminum planks shall be bolted type with dimensions, holes, lengths, and cross sections as detailed on the plans. The extruded aluminum molding for edging of the extruded aluminum sign panels shall be of the cross section as detailed on the plans. Extruded aluminum planks shall conform to ASTM B221M [ASTM B221], 6063-T6, 6005-T5 or 6061-T6. The extruded aluminum planks and molding shall be free from all corrosion and dirt and the face and edges shall be true and smooth and free from burrs and breaks.

(a) Degreasing - Required on aluminum plank by either of the following methods:

1. Vapor Degreasing shall be by total immersion of the plank in a saturated vapor of trichloroethylene or perchloroethylene. Trademark printing shall be removed with lacquer thinner or controlled alkaline cleaning system.
2. Alkaline Degreasing - Planks shall be immersed in a tank containing alkaline solutions, controlled and titrated to the solution manufacturer's specification. Immersion time shall depend upon the amount of soil present and the gauge of the metal.

(b) Etching

1. Alkaline Etch

The pre-cleaned aluminum surface shall be well etched in an alkaline etching material that is controlled by titration, use time, temperature and concentration specified by the solution manufacturer and rinsed thoroughly. Smut shall be removed with an acidic, chromium compound type solution as specified by the solution manufacturer and then thoroughly rinsed.

2. Alodine 500 or 1,200 is acceptable.

(c) Drying

Material may be air dried or oven dried. Metal shall not be handled except by device or clean 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 application of Reflective Sheeting.

(d) Fabrication

All fabrication shall be completed prior to metal degreasing.

719.04 Aluminum Sheets. All blanks shall be made of 5052-H38 or 6061-T6 aluminum. The Contractor shall guarantee the material to be free of buckles, warp, dents, cockles, burrs and defects resulting from fabrication.

(a) Degreasing - Required on sheet aluminum by either of the following methods:

1. Vapor Degreasing - Sign blanks shall be totally immersed in a saturated vapor of trichlorethylene or perchloroethylene. Trademark printing shall be removed with lacquer thinner or controlled alkaline cleaning system.
2. Alkaline Degreasing - Sign blanks shall be totally immersed in a tank containing alkaline solutions, controlled and titrated to the solution manufacturer's specifications. Immersion time shall depend upon the amount of soil present and the gauge of the metal.

(b) Etching

1. Alkaline Etch - The pre-cleaned aluminum surface shall be well etched in an alkaline etching material that is controlled by titration, use time, temperature and concentration specified by the solution manufacturer, and rinsed thoroughly. Smut shall be removed with an acidic, chromium compound type solution as specified by the solution manufacturer and then thoroughly rinsed.
2. Alodine 500 or 1,200 is acceptable.

(c) Drying

Material may be air dried or oven dried. Metal shall not be handled except by device or clean gloves between all cleaning and etching operation and packaging. There shall be no opportunity for metal to come in contact with grease, oils, or other contaminants prior to application of to packaging and shipping.

(d) Fabrication

All fabrication, including shearing, cutting and punching of holes shall be completed prior to metal degreasing. Fabrication of all metal parts shall be accomplished in a uniform and workmanlike manner. The surface of all sign panels shall be flat.

The minimum sheet thickness shall be 2.00 mm [0.08 inches] for signs of an area of 1.1 m² [12 square feet] or less and shall be 3.18 mm [0.125 inches] for signs over 1.0 m² [12 square feet] unless otherwise specified.

(e) Chromate Treatment

Treatment shall be in accordance with ASTM B449 Class I.

719.05 Plywood. The plywood shall conform to the following requirements:

- (a) Face stock-Face veneers shall be Grade A.
- (b) Core and Cross Veneers-Core and crossband veneers shall be Grade B or better and shall be solid jointed.
- (c) Glue. The entire area of each contacting veneer surface shall be bonded with a waterproof adhesive that meets the test requirements for exterior type.
- (d) Overlay. The overlay shall be of the high-density type. It shall be a minimum of 0.29 kg/m² [60 pounds per 1,000 square feet] surface, shall be at least 0.229 mm [0.009 inch] thick and have a minimum resin content of 40 percent based on the dry weight of the impregnated fiber. It shall consist of at least 2 sheets of resin-impregnated fiber of sufficient resin content to bond itself to the plywood. Manufacturing precautions shall be taken to prevent overlay surfaces from coming into contact with any substance which would inhibit adhesion of paint or reflective sheeting. The overlay shall be natural color.
- (e) Thickness. The thickness of plywood shall be 16 mm [5/8 inch].
- (f) Testing. The plastic overlay shall not delaminate from the plywood after being subjected to the exterior boiling test for glue line durability.

719.06 Demountable Reflectorized Delineators. Delineators shall be diamond reflectors approximately 75 mm [3 inches] square or shall be rectangular, adhesive coated reflective sheeting permanently adhered to a sheet aluminum backing. All delineators on a project shall be the same type. Single delineators shall be clear or silver-white; double and triple delineators shall be amber.

- (a) Single delineators shall have one 6 mm [$\frac{1}{4}$ inch] square hole for center mounting. Double and triple delineators shall have two 6 mm [$\frac{1}{4}$ inch] square mounting holes on the vertical centerline.

Single delineators shall be 75 by 75 mm [3 by 3 inch] diamonds with 19 mm [$\frac{3}{4}$ inch] radius corners and two 6 mm [$\frac{1}{4}$ inch] square mounting holes, 75 mm [3 inches] on center. Double delineators shall be 75 x 150 mm [3x6 inch] rectangles with 19 mm [$\frac{3}{4}$ inch] radius corners and two 6 mm [$\frac{1}{4}$ inch] square mounting holes 125 mm [5 inches] on center.

The aluminum shall be 6061-T6, ASTM B209 or 6063-T6 or 6005-T5 1.60 mm [0.063 inch] thick sheet properly degreased and etched or treated with a light, tight amorphous chromate type coating.

The reflective sheeting shall be applied to properly treated base panels with mechanical equipment in a manner specified by the sheeting manufacturer.

- (b) General Requirements and Packaging. The finished delineators shall show careful workmanship, be free of burrs, scratches or damaged reflective surface.

Delineators shall be packaged in such a manner as to insure their arrival at destination in undamaged condition. Delineators shall not become wet in storage or shipment.

719.07 Assembly Hardware. The bolts required to attach the extruded aluminum planks together shall conform to the designs used in standard commercial processes for the type of extruded aluminum panels to be used, as approved by the Engineer. Aluminum Zee Bars, where shown on the plans, shall be of 6061-T6 or 6063-T6 or 6005-T5 aluminum conforming to ASTM B221M [ASTM B221]. Post Clips shall be 356-T7 aluminum conforming to ASTM B108. Panel Bolts, Clip Bolts and all washers shall be 2024-T4 aluminum, Hex Nuts shall be 6262-T9 aluminum, both conforming to ASTM B211M [ASTM B211].

Signs mounted on steel H-beam posts shall be attached using a method recommended by the extruded plank manufacturer or as shown on the plans.

Nuts, bolts, and washers for assembling metal sign components shall be stainless steel, ASTM F 593, alloy group 1. All nuts shall be of the self-locking type. Aluminum signs mounted on U-channel posts shall be attached with stainless steel ASTM F 593, alloy group 1, 8 by 25 mm [$\frac{5}{16}$ by 1 $\frac{1}{2}$ inch] bolts and washers, and an approved washer will be used on the face of

signs. Signs mounted on wood posts shall be attached with 8 by 38 mm [5/16 by 1 1/2 inch] stainless steel lag screws.

Plywood signs mounted on U-channel posts shall be attached with M8 by 60 mm [5/16 by 2 1/2 inch] cap screws and standard hex nuts conforming to ASTM F568 Class 4.6 [ASTM A307], galvanized in accordance with ASTM A153. A galvanized steel washer shall be used under the nut and an approved washer shall be used between the head of the bolt and the face of the sign.

Signs

mounted on wood posts shall be attached with M8 by 90 mm [5/16 by 3 1/2 inch] stainless steel lag screws. Approved washers shall be used to protect the sign face from the fastener head.

Delineator assembly hardware shall consist of M6 by 60 mm [1/4 inch by 2 1/4 inch] zinc plated hex bolts, and self- locking nuts.

SECTION 720 -- STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TRAFFIC SIGNALS

720.01 Aluminum Supports. Extrusions for aluminum supports shall conform to ASTM B221M [ASTM B221] or ASTM B429, Alloy 6061-T6 or 6063-T6. Castings for use with aluminum supports shall conform to ASTM B26/B26M or B108, Alloy 356.0-T6, except that castings for parts having a non-structural application, such as pole caps or bolt covers, may be temper F. The T6 tempers specified for Alloys 6063 and 356.0 shall be obtained by the proper heat treatment of the assemblies after all welding for the base and if required, for the handhole reinforcement has been completed. No welding will be allowed on the shaft other than as required for the attachment of the shoe base, handhole reinforcement and bracket arm.

The exterior of all parts shall have a satin brushed or satin etched finish. The assemblies shall be free of bulges, dents, cracks and on external surfaces, discoloration and scratches. The presence of any of these defects or any other imperfection detrimental to strength or appearance may be cause for rejection by the Engineer. All assemblies shall be tire wrapped for protection during shipment, storage and handling.

All ends of shafts open to the weather shall be fitted with a cast-aluminum or formed aluminum cap secured in place with set screws.

All assemblies shall be permanently marked on the edge of the base or flange, showing alloy and temper, diameter and wall thickness of the shaft.

- (a) Light Standards, Mast arm Poles, Strain Poles and Dual Purpose Poles. Shafts shall be round, tapered and seamless and shall be fabricated as a single continuous unit without splices, except that shafts with a length of over 12 m [40 feet] may be fabricated with one splice at approximately mid-height and dual purpose poles may be fabricated with a splice immediately above the mast arm attachment. The minimum wall thickness of the shaft shall be 4.78 mm [0.188 inches]. A handhole of approximately 0.016 m² [25 square inches] in area, reinforced to maintain the

full design strength of the shaft, shall be provided approximately 450 mm [18 inches] above the base. Provisions for internal grounding shall be incorporated in the handhole reinforcement. A hole, fitted with a rubber grommet, shall be provided in the shaft to match the wire-way of the bracket arm or mast arm, except that strain poles shall be provided with a wire inlet as shown on the standard details. Bases shall be shoe type and shall be supplied with suitable covers for the anchor bolts. Anchor bolt covers shall be securely fastened to the base by means of one or more stainless steel phillips or hex head screws with a minimum size of 6 mm [$\frac{1}{4}$ inch]. Bases shall be welded to the shaft with both an internal and external continuous fillet weld. The use of sleeve type bases or other bases not requiring welding of the shaft to the base and the use of reinforcing sleeves will not be allowed.

Dual purpose poles shall be provided with a pull wire for the luminaire.

- (b) Colonial Light Standards. Shafts shall be round, tapered and seamless and shall be fabricated as a single continuous unit without splices. The minimum wall thickness shall be 3.175 mm [0.125 inches] and the minimum diameter at the base shall be 125 mm [5 inches]. The length of the shaft plus the base shall be 4.34 m [14 feet and 3 inches], with a 100 mm [4 inch] long by 75 mm [3 inch] OD straight section at the top to accept the pole top luminaire. The entire assembly of pole and base shall be black anodized. Bases shall be handhole type with a handhole of approximately 0.016 m² [25 square inches] in area and equipped with an approved locking device on the handhole cover. The bases shall have internal flanges capable of accepting four M20 [$\frac{3}{4}$ inch] anchor bolts, equally spaced on a 250 mm [10 inch] diameter bolt circle. The bases shall be welded to the shaft with both an internal and an external continuous fillet weld.
- (c) Pedestal Poles. Shafts shall be round, tapered and seamless and shall be fabricated as a single continuous unit without splices. The minimum outside diameter at the base shall be 150 mm [6 inches] and the minimum wall thickness shall be 3.175 mm [0.125 inches]. The length of the pole plus the base shall be 3 m [10 feet], except that the length of poles supporting only pedestrian heads shall be 2.4 m [8 feet]. Bases shall be transformer type with suitable covers for the anchor bolts. The bases shall be welded to the shaft with an external and an internal fillet weld.
- (d) Sign Supports. Shafts shall be round, seamless and of uniform cross section and shall be fabricated as a single continuous unit without splices. The minimum wall thickness shall be 3.175 mm [0.125 inches]. Bases shall be shoe type as specified under Subsection 720.01(a).
- (e) Sign Bridges, Cantilever Type and Butterfly Type Sign Supports. The configuration of the foundation(s), base(s), shaft(s), arm(s) or truss shall be of the Contractor's design as approved by the Engineer and shall use only material as specified above. Sleeve type bases or other bases not requiring welding to the shaft and the use of reinforcing sleeves will not be allowed.

720.02 Aluminum Mast Arm and Bracket Arm. Mast arms and bracket arms shall be of the same materials as the matching pole and have a similar finish. Member cross sections shall be either round or elliptical and have a minimum wall thickness of 3.175 mm [0.125 inches]. Internal diameters, bends, joints and attachments shall permit internal wiring in the upper member of the arms. Fixtures for attaching the arms to the poles shall be either castings or extrusions, sized to meet the design requirements and shall be designed to prevent rotation of the arms about the poles. Any mechanical means used to prevent rotation shall completely penetrate both the fixture and the shaft and the use of set screws will not be allowed.

- (a) Mast Arms for Signals. Mast arms shall be of the tapered tube truss type design, consisting of an upper and a lower member with vertical struts, welded to form an integral unit or single member tapered arm. Mast arms shall be equipped with sturdy signal hangers and/or appropriate tenons for mounting the signal heads and shall have weatherproof wire inlets located close to the suspended signal heads.
- (b) Bracket Arms for Luminaires. Bracket arms shall be of the single member or truss type. Single member type bracket arms shall be of the tapered upsweep design. Truss type bracket arms shall be of a tapered tube design, consisting of an upper and a lower member and a single vertical strut, welded to form an integral unit. Arms shall be equipped with an appropriate tenon for the attachment of the luminaire.

720.03 Steel Supports. Tapered shafts for steel supports shall conform to ASTM A595, Grade A or approved equal. Straight shafts for steel supports shall conform to ASTM A53, Grade B; A 500, Grade A or approved equal. Flanges shall be fabricated of steel plate conforming to ASTM A36/A36M or ASTM A572/A572M, Grade 345 [Grade 50] and shall be sized to transmit the full design load of the shaft. The flanges shall be welded to the shafts with either a continuous internal and external fillet weld or with a full penetration groove weld.

The interior and exterior of all parts shall be hot dip galvanized in conformance with AASHTO M111 (ASTM A123), after all welding and/or other fabrication processes have been completed. The finished assemblies shall be free of bulges, dents, cracks and scratches on external surfaces. The presence of any of these defects or any other imperfection detrimental to strength or appearance may be cause for rejection. All assemblies shall be tire wrapped for protection during shipment, storage and handling.

All nuts, bolts and washers, other than anchor bolts and their associated washers and nuts, shall conform to AASHTO M164M [AASHTO M164], ASTM A325M [ASTM A325] Type I or ASTM F568 Class 3.8 [ASTM A449] and shall be hot dip galvanized in conformance with AASHTO M232 (ASTM A153). After galvanizing, nuts shall be retapped oversize by an amount appropriate to the nut size.

All ends of shafts open to the weather shall be fitted with an appropriate cast aluminum or galvanized cast iron cap secured in place with set screws.

All assemblies shall be permanently marked on the edge of the base or flange showing steel type and grade, diameter and wall thickness of the shaft.

- (a) Light Standards, Mast Arm Poles, Strain Poles and Dual Purpose Poles. Shafts shall be round and either tapered or of uniform cross section and shall be fabricated as a single continuous unit without splices, except that shafts with a length over 12 m [40 feet] may be fabricated with one splice at approximately mid-height and dual purpose poles may be fabricated with a splice immediately above the mast arm attachment. The minimum wall thickness of shafts shall be number 7 gauge. A handhole of approximately 0.016 m² [25 square inches] in area, reinforced to maintain the full design strength of the shaft, shall be provided approximately 450 mm [18 inches] above the base. Provisions for internal grounding shall be provided in a location accessible through the handhole. A hole, fitted with a rubber grommet, shall be provided in the shaft to match the wire-way of the bracket arm or mast arm, except that strain poles shall be provided with a wire inlet as shown on the standard details.

On dual purpose poles a pull wire shall be provided for the luminaire.

- (b) Pedestal Poles. Shafts shall be 100 mm [4 inches] nominal ID, schedule 40 pipe without splices. The length of the pole plus the base shall be 3 m [10 feet], except that the length of poles supporting only pedestrian heads shall be 2.4 m [8 feet].
- (c) Sign Supports. Shafts shall be round, seamless and of uniform cross section and shall be fabricated as a single continuous unit without splices. The minimum wall thickness shall be number 11 gage.
- (d) Sign Bridges, Cantilever Type and Butterfly Type Sign Supports. The configuration of the foundation(s), base(s), shaft(s), arm(s) or truss shall be of the Contractor's design as approved by the Engineer and shall use only material as specified above. The use of a single tubular member for the member supporting the signs will not be allowed.

720.04 Steel Mast Arm and Bracket Arm. Material for mast arms and bracket arms shall be ASTM A595, Grade A. Steel for flanges and attachments shall conform to AASHTO M183/M183M (ASTM A36/A36M) or AASHTO M223/M223M Grade 50 (ASTM A572/A572M, Grade 345). Internal diameters, bents, joints and attachments shall permit internal wiring in the upper member of the arms. Arms shall be hot dipped galvanized, both inside and outside, in conformance with AASHTO M111 (ASTM A123).

- (a) Mast arms for Signals. Mast arms may be of the single member or the truss type. Single member type mast arms shall be a single, straight or tapered, round member and may incorporate a maximum of 2 telescopic splices. Truss type mast arms shall be of a tapered design consisting of an upper and a lower member connected by vertical struts welded to form an integral unit. Mast arms shall be equipped with sturdy signal hangers and/or appropriate tenons for

mounting the signal heads and shall have weatherproof wire inlets located close to the suspended signal heads.

- (b) Bracket Arms for Luminaires. Bracket arms may be of the single member or the truss type. Single member type bracket arms shall be of the tapered upsweep design. Truss type bracket arms shall be of a tapered design consisting of an upper and lower member connected by a single vertical strut, welded to form an integral unit. Bracket arms shall be equipped with an appropriate tenon for the attachment of the luminaire.

720.05 High Mast Light Standard. High mast light standards shall have a cross section that is either round or polygonal with not less than 12 sides, and shall have a uniform taper from the base to the top, except that an expanded base section may be used, if required, to accommodate the electrical and mechanical equipment. The shaft shall be fabricated with welded shop splices not less than 7.5 m [25 feet] apart and a field splice not less than 12 m [40 feet] above the base plates. Additional field splices, required above the 12 m 40 foot level, shall be not less than 9 m [30 feet] apart. The top section of a shaft may be of the length required to obtain the specific shaft length, but shall be not less than 4.6 m 15 feet in length. Sections may be fabricated with a maximum of two longitudinal welded seams. The welded shop splices shall be AWS prequalified, full penetration, butt welds. The welded longitudinal seams shall have 100 percent penetration for 150 mm [6 inches] on either side of a shop splice, and for the splice length plus 150 mm [6 inches] at the field splice end(s) of a shaft section. The remainder shall be welded with a process capable of developing a minimum effective weld throat of 60 percent of the wall thickness. The Contractor shall submit prequalification tests for all welds that are not AWS prequalified. Field splices shall be of the telescopic type and shall be designed to maintain the full strength and rigidity of the shaft. The minimum length of a field splice shall be 600 mm [2 feet]. The base shall be welded to the shaft with an AWS prequalified full penetration weld. If a backup plate is used for this weld, it shall be removed following the completion of the weld and the weld shall be ground to an acceptable contour. All work shall conform to the applicable provisions of Section 504 -- Structural Steel.

One hundred percent of all circumferential welds and the full penetration sections of the longitudinal seam welds shall be inspected radiographically. Ten percent of the partial penetration sections of the longitudinal seam welds shall be inspected by the magnetic particle method. All unacceptable defects shall be corrected, except that lack-of-penetration defects located more than 375 mm [15 inches] from the field splice end(s) of a shaft section, and being less than 50 mm 2 inch in length, need not be repaired. All weld repairs shall be reinspected by the applicable method, except that any weld repairs located more than 375 mm [15 inches] from the field splice end(s) of a shaft section and repaired under the direct supervision of the Engineer and accepted by the Engineer, need not be reinspected. Ultrasonic testing may be used on material over 8 mm [5/16 inch] thick with the approval of the Engineer.

Material for the shaft, base and attachments shall conform to the requirements of AASHTO M222/M222M (ASTM A588/A588M) or ASTM A595, Grade C. The Contractor shall submit 2 copies of the mill test reports covering the material used.

All shaft sections shall have walls consisting of one plate thickness. Walls consisting of more than one layer of metal will not be allowed, except that a doubler plate may be used around the equipment access opening. The walls of polygonal shafts shall have an inside corner radius to wall thickness ratio not less than 2.

Prior to erection, the completely assembled shaft shall not exhibit a sweep in excess of 0.2 percent of the nominal pole height, as measured with the shaft in a horizontal position on a flat and approximately level surface. For shafts that are to remain in the bare, unpainted condition, the lower edge of all field splices shall be sealed along the entire circumference with a sealant, approved by the Engineer, that will remain flexible over the entire temperature range at the side(s) of the shaft(s) in question and that will not deteriorate due to exposure to ultraviolet light.

The shaft shall be provided with an equipment access opening approximately 0.19 m² [2 square feet] in area and located approximately 600 m [2 feet] above the base. The access opening shall be reinforced to maintain the full design strength of the shaft and shall be provided with a hinged, removable, access door equipped with a vandalproof means of being locked in place. All welds for the access opening reinforcement shall be full penetration welds. A positive means of internal grounding shall be provided inside the access door.

The Contractor shall make all tests required under the specifications, furnishing all equipment, material, labor and all incidentals necessary to complete the tests. The tests shall be made at the direction and in the presence of the Inspector for the Maine Department of Transportation. All costs to the Contractor will be considered incidental to the related contract items and no separate payments for tests will be made.

720.06 Steel H-beam Poles. Steel H-beam Poles shall conform to AASHTO M183/M183M (ASTM A36/A36M), shall be fabricated in accordance with the provisions of Section 504 -- Structural Steel and shall be hot dipped galvanized in accordance with AASHTO M111 (ASTM A123). All steel hardware for use with H-beam poles shall be hot dipped galvanized in accordance with AASHTO M232.

720.07 Anchor Bolts. Anchor bolts and nuts supplied for aluminum and/or steel supports shall conform to ASTM A576, Grades 1021 through 1046, with a minimum yield strength of 345 000 MPa [50,000 psi]. Nuts for anchor bolts shall conform to ASTM A563M [ASTM A563], Grade C and shall be heavy hex nuts. Anchor bolts shall be supplied with 2 nuts and 2 hardened washers and shall have a 90 degrees bend with a 150 mm [6 inch] minimum leg length at the lower end. The anchor bolts, the nuts and the hardened washers shall be hot dipped galvanized to ASTM A123. After galvanizing the nuts shall be retapped oversize by an amount appropriate to the nut size. If the anchor bolts are to be used with breakaway devices incorporating the function of a nut, for example, longitudinally grooved breakaway couplings, nuts or washers will not be required.

Alternate materials and designs may be used for the anchor bolts subject to approval.

720.08 U-Channel Posts. Except as otherwise authorized, U-Channel posts for secondary road regulatory, warning, confirmation and route marker assembly signs and for supporting demountable reflectorized delineators shall be fabricated of steel of the size shown on the plans.

Aluminum U-channel posts having the same strength characteristics as steel U-channel posts may be used, subject to the approval of the Engineer. The steel U-channel posts shall be galvanized in accordance with AASHTO M111 (ASTM A123).

720.09 Wood Ornamental Light Standard. Material for wood light standards shall be Western Red Cedar (*Rhuja Plicata*) or other species with equal or better decay resistance, approved by the Engineer.

The wood cross section shall be 250 x 250 mm [10 by 10 inches] minimum. The mounting height and depth of burial shall be as shown on the plans.

The following items shall be supplied, a 50 mm [2 inch] slipfitter of corrosion resistant material of adequate length to support the luminaire, a sideplowed wire-way covered by a suitable flush filler strip to accommodate three, number 12 conductors, a pair of two-piece plinths for conduit entrance and splice box.

All bolts shall be hot dipped galvanized in accordance with AASHTO M232 (ASTM A153).

All parts of the wood light standard shall be prefitted and predrilled, holes shall be counterbored to conceal bolts and filled with mastic compound.

The wood light standard surface finish shall be as indicated on the plans.

720.10 Wood Utility Pole. Wood poles shall be Douglas Fir or Southern Yellow Pine, conforming to ANSI Standard Specification 05.1 and of the class and length as indicated on the plans.

Poles shall not have more than 180 degrees twist in grain over the full length. Sweep shall be no more than 100 mm [4 inches]. Tops of poles shall be beveled.

Wood poles shall be pressure treated, after fabrication, with creosote, pentachlorophenol (oil borne), pentachlorophenol liquified petroleum gas solution or copper naphthenate (oil borne), in accordance with the latest AWWA Specification C4 for pressure treated wood poles.

720.11 Mast Arms for Wood Utility Poles. All mast arms for wood utility pole attachment shall be standard 50 mm [2 inch] diameter pipe of specified length and shall include a mast arm head, universal joint, insulated wire inlet, tie rods, cross arm and mounting brackets. The vertical distance between the mast arm and point of attachment of the cross arm shall not be less than 40 percent of the mast arm length. All attachments for mast arm assemblies shall be designed to withstand stresses due to the mast arm and signal weights and wind loads generated by a 145 km/hr [90 mile per hour] wind.

720.12 Wood Sign Posts. Wood sign posts shall be rectangular, straight and sound timber, cut from live growing native spruce, hemlock, cedar or Douglas Fir trees, free from loose knots or other structurally weakening defects of importance, such as shake or holes and heart rot. A tolerance of 25 mm [1 inch] in length and 6 mm [¼ inch] in width or thickness is permitted in the

dimensions of rectangular posts. They shall be sawn true and planed 4 sides. Nominal dimensions of rectangular posts shall be as given on the plans. The top shall be cut on a 22 degree bevel plus or minus 2 degrees.

Wood sign posts with 0.016 m² [25 square inches] or more of cross sectional area shall have an adequate quantity of material removed by drilling holes as shown on the plans to reduce the cross sectional area of the solid post to 0.016 m² [25 square inches].

When pressure treated wood sign posts are called for on the plans, the wood shall be Yellow Pine, Number 2 or better, .40 CCA, D4 S. The pressure treated wood shall meet AWP Standard P-5 or Federal Standard TT-W-550. The treating process shall meet Federal Specification TT-W-571, or AWP Commodity Standards as applicable.

SECTION 721 -- BREAKAWAY DEVICES

721.01 Breakaway Devices. Breakaway devices shall be capable of supporting all design loads and shall conform in all respects to the requirements of the latest AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals".

Cast aluminum sleeve type bases, steel breakaway poles or any breakaway supports that require the use of tools, other than simple mechanic's tools, for the replacement of parts after having been struck or require the replacement of all or part of the light standard or sign support itself in order to be restored to service after having been struck, will not be allowed.

- (a) Aluminum Breakaway Couplings. Aluminum breakaway couplings shall be fluted aluminum castings or extrusions designed to be mounted on the anchor bolts supplied for light standards. The coupling shall incorporate in its upper end a suitable threaded stud and be equipped with a matching heavy hex nut and hardened washer. The stud, nut and washer shall be hot dipped galvanized or shall be of corrosion resistant steel.

The aluminum breakaway coupling shall be designed to sustain all axillary applied design loads and to fracture under the application of transverse impact loads.

- (b) Aluminum Breakaway Transformer Bases. Aluminum breakaway transformer bases shall be standard aluminum transformer bases modified either metallurgically or structurally to conform to the requirements of the above AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. They shall be clearly and permanently identified as "Breakaway Base" in two conspicuous places, one of which must be on an outside exposed surface.
- (c) Breakaway Bases using Load-Concentrating Couplings. The load-concentrating couplings and their supports shall be designed to carry all loads, other than impact

loads, in such a way that the couplings are stressed axially and no moments, sufficient to fracture the couplings, are induced in the couplings. The load-concentrating couplings shall also be designed and supported in such a way that forces induced in them by vehicular impact shall cause them to fail in bending and to cause a complete separation between the foundation and the supported structure.

- (d) Hinges. Hinge plates shall be dimensioned to transmit the full design moment of the support with a safety factor of not less than 1.00 nor more than 1.20, as determined by using the ultimate tensile stress range of hinge material.

SECTION 722 -- GEOTEXTILES

722.01 Stabilization Geotextile. The geotextile shall have property values expressed in "minimum" or "minimum average roll" values that meet or exceed the values stated below, as determined by the most recent test methods specified below. All mechanical property values expressed as "average" or "typical" shall be reduced by 20 percent and then compared to the values stated below.

Woven and nonwoven geotextiles are acceptable and must meet the following requirements:

<u>Geotextile</u> <u>Mechanical Property</u>	<u>Test Method</u>	<u>Minimum</u> <u>Permissible</u> <u>Value</u>
Grab Tensile Strength (both directions)	ASTM D4632 or ASTM D503 and ASTM D5035	800 N [180 pounds]
Grab Elongation	ASTM D4632 or ASTM D5034 and ASTM 5035	15 percent
Mullen Burst Strength	ASTM D3786 or ASTM D751	2000 kPa [290 psi]
Puncture Strength	Modified ASTM D3787 or modified ASTM D751	330 N [75 pounds]
Trapezoid Tear Strength	ASTM D4533 or ASTM D1117	220 N [50 pounds]
<u>Geotextile</u> <u>Hydraulic Property</u>	<u>Test Method</u>	<u>Permissible Value</u>
Apparent Opening Size (AOS)	CW-02215	Sieves Sizes between 850 µm 150 µm [U.S. Std. Sieve number(s) between No.20 and No.100]

Permeability

ASTM D4491

0.01 mm/sec

722.02 Drainage Geotextile. The geotextile shall have property values expressed in "minimum" or "minimum average roll" values that meet or exceed the values stated below, as determined by the most recent test methods specified below. All mechanical property values expressed as "average" or "typical" shall be reduced by 20 percent and then compared to the values stated below.

Both woven and nonwoven geotextiles are acceptable, however, no "slit-tape" woven fabrics will be permitted. The geotextile must meet the following requirements:

<u>Geotextile Mechanical Property</u>	<u>Minimum Test Method</u>	<u>Permissible Value</u>	
		Class A*	Class B*
Grab Tensile Strength (both directions)	ASTM D4632 or ASTM D5034 and ASTM D5035	800 N [180 pounds]	356 N [80 pounds]
Grab Elongation	ASTM D4632 or ASTM D5034 and ASTM D5035	15 percent	15 percent
Mullen Burst Strength	ASTM D3786 or ASTM D751	2000 kPa [2900 psi]	896 kPa [130 psi]
Puncture Strength Modified or modified	ASTM D 3787 ASTM D751	356 N [80 pounds]	110 N [25 pounds]
Trapezoid Tear Strength	ASTM D4533 or ASTM D1117	220 N [50 pounds]	110 N [25 pounds]
<u>Geotextile Hydraulic Property</u>	<u>Test Method</u>	<u>Permissible Value</u>	
Apparent Opening Size (AOS)	CW-02215	Sieves Sizes between 850 µm and 150 µm [U.S. Std. Sieve number(s) between No.20 and No.100]	
Permeability	ASTM D4491	0.01 mm/sec	

- * Class A Drainage applications are those where installation stresses are more severe than Class B applications, such as where very sharp angular aggregate is in contact with the fabric, or a heavy degree of compaction is required.
- * Class B Drainage applications are those where installation stresses are less severe such as where fabric is used with smooth graded surfaces having no sharp angular

projections, no sharp angular aggregate is used, or where compaction requirements are light.

722.03 Erosion Control Geotextile. The geotextile shall meet or exceed the values stated below as determined by the most recent test methods specified below. All mechanical property values expressed as "average" or "typical" shall be reduced by 20 percent and then compared to the values stated below.

Both woven and nonwoven geotextiles are acceptable, however, no "slit-tape" woven fabrics will be permitted. The geotextile must meet the following requirements:

<u>Geotextile Mechanical Property</u>	<u>Test Method</u>	<u>Minimum</u>	
		<u>Permissible</u> Class A*	<u>Value</u> Class B*
Grab Tensile Strength (both directions)	ASTM D4632 or ASTM D5034 and ASTM D5035	890 N [200 pounds]	400 N [90 pounds]
Grab Elongation	ASTM D4632 or ASTM D5034 and ASTM D5035	15 percent	15 percent
Mullen Burst Strength	ASTM D3786 or ASTM D751	2200 kPa [320 psi]	1000 kPa 145 [psi]
Puncture Strength	Modified ASTM D3787 or modified ASTM D751	356 N [80 pounds]	178 N [40 pounds]
Trapezoid Tear Strength	ASTM D4533 or ASTM D1117	220 N [50 pounds]	130 N [30 pounds]
<u>Geotextile Hydraulic Property</u>	<u>Test Method</u>	<u>Permissible Value</u>	
Apparent Opening Size (AOS)	CW-02215	Sieve sizes between 850 µm and 150 m] [U.S. Std. Sieve number(s) between No. 20 & No. 100]	
Permeability	ASTM D4491	0.01 mm sec	

* Class A Erosion control applications are those where installation stresses on the fabric are more severe than Class B such as when no aggregate cushion is used or rock weights are greater than 113 kg [250 pounds].

* Class B Erosion control applications are those where fabric is protected from plain or hand laid riprap or stone ditch protection by a 150 mm [6 inch] thick protective aggregate cushion.

722.04 Reinforcement Geotextile. The geotextile shall have property values expressed in "minimum" or "minimum average roll" values that meet or exceed the values stated below as determined by the most recent test methods specified below. All mechanical property values expressed as "average" or "typical" shall be reduced by 20 percent and then compared to the value stated below.

Woven and nonwoven geotextiles are acceptable and must meet the following requirements:

<u>Geotextile Mechanical Property</u>	<u>Test Method</u>	<u>Minimum Permissible Value</u>
Grab Tensile Strength (both directions)	ASTM D4632 or ASTM D5034 and ASTM D5035	1200 N [270 pounds]
Grab Elongation	ASTM D4632 or ASTM D5034 and ASTM D5035	15 percent
Mullen Burst Strength	ASTM D3786 or ASTM D751	2960 kPa [430 psi]
Puncture Strength	Modified ASTM D3787 or modified ASTM D751	490 N [110 pounds]
Trapezoid Tear Strength	ASTM D4533 or ASTM D1117	334 N [75 pounds]
<u>Geotextile Hydraulic Property</u>	<u>Test Method</u>	<u>Permissible Value</u>
Apparent Opening Size (AOS)	CW-02215	Sieve size between 850 μm and 150 μm [U.S. Std Sieve number(s) between No. 20 and No. 100]
Permeability	ASTM D4491	0.01 mm/sec

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